PATENT

Attorney Docket No. IP 116.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

JAMES A. COOKE

Serial No. 10/711,193

Filed: August 31, 2004

For: TRANSMISSION

Group Art Unit 3683

Examiner: Mahbubur Rashid

CORRECTED APPEAL BRIEF

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In response to the Notice of Non-Compliant Appeal Brief, Appellant submits this Corrected Appeal Brief.

I. REAL PARTY OF INTEREST

The real party in interest is SRAM, LLC. SRAM, LLC's right to take action in the subject application was established by virtue of an Assignment from the SRAM Corporation to SRAM, LLC recorded at Reel/Frame 021617/0263.

II. RELATED APPEALS AND INTERFERENCES

The undersigned legal representative of Appellant hereby confirms that there are no known appeals or interferences relating to the present application, or any parent application, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1, 3, 4, 6-10, 12, 13 and 15-18 are pending in the application. No claims are allowed. Claims 1, 3, 4, 6-10, 12, 13 and 15-18 have been rejected. Claims 2, 5, 11 and 14 are cancelled. Rejection of claims 1, 3, 4, 6-10, 12, 13 and 15-18 is being appealed.

IV. STATUS OF THE AMENDMENTS

No amendments have been filed after the final office action dated September 8, 2008.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The claims are generally directed toward a transmission. Claims 1 and 10 are independent claims. No claim includes a means plus function elements as permitted by 35 U.S.C. 112, paragraph six.

Independent claim 1 as currently pending recites a transmission 10 including an input shaft 14 and an input cog assembly 12 mounted to the input shaft 14 (paragraph 24, lines 4-6 and FIGS. 1-7). The input cog assembly 12 includes a plurality of varying diameter input cogs 36-49 arranged sequentially (paragraph 26, lines 2-4 and FIGS. 1-7). An output shaft 18 is disposed substantially parallel to the input shaft 14 (paragraph 26, lines 1-2 and

FIGS. 1-7). An input device 11 is concentric with the output shaft 18 and connected to the input shaft 14 with a first flexible torque-transmitting element 30 (paragraph 25, lines 1-6 and FIGS. 1-7). An output device 24 is connected to the output shaft 24 with a second flexible torque-transmitting element 22 (paragraph 24, lines 7-10 and FIG. 1). An output cog assembly 16 is mounted to the output shaft 18 (paragraph 24, line 6 and FIGS. 1-7). The output cog assembly 16 includes a plurality of varying diameter output cogs 50-63 arranged sequentially (paragraph 26, lines 2-4 and FIGS. 1-7). A chain 20 links one of the plurality of the input cogs 36-49 and one of the plurality of output cogs 50-63 disposed opposite the one of plurality of input cogs 36-49 for transmitting power from the input cog assembly 12 to the output cog assembly 16 (paragraph 24, line 7, FIGS. 1-7). The chain 20, in operation, has a high-tension side 66 and a low-tension side 64 (paragraph 27, lines 4-5 and FIGS. 2-6). A derailleur 26 is engageable with the low-tension side 64 of the chain 20 to laterally urge the chain 20 from a current output cog 56 to a destination output cog 57 (paragraph 27, lines 5-7). The input and output cog assemblies 12, 16 are disposed in close proximity to each other and in a complementary arrangement relative to each other with the plurality of input cogs 36-49 substantially aligned with the plurality of output cogs 50-63 in a paired arrangement (paragraph 26, lines 4-6 and FIGS. 1-7) such that in operation the high-tension side 66 of the chain 20 automatically shifts to the input cog 43 directly opposite the destination output cog 57 after the derailleur 26 laterally displaces the chain 20 from the current output cog 56 to the destination output cog 57 (paragraph 27, lines 7-10).

Independent claim 10 as currently pending recites a transmission 10 including an input shaft 14 and an input cog assembly 12 mounted to the input shaft 14 (paragraph 24, lines 4-6 and FIGS. 1-7). The input cog assembly 12 includes a plurality of input cogs 36-49 (paragraph 26, lines 2-4 and FIGS. 1-7). An output shaft 18 is disposed substantially parallel to the input shaft 14 (paragraph 26, lines 1-2 and FIGS. 1-7). An input device 11 is concentric with the output shaft 18 and connected to the input shaft 14 with a first flexible torque-transmitting element 30 (paragraph 25, lines 1-6 and FIGS. 1-7). An output device 24 is connected to the output shaft 24 with a second flexible torque-transmitting element 22

(paragraph 24, lines 7-10 and FIG. 1). An output cog assembly 16 is mounted to the output shaft 18 (paragraph 24, line 6 and FIGS. 1-7). The output cog assembly 16 includes a plurality of output cogs 50-63 (paragraph 26, lines 2-4 and FIGS. 1-7). One of the input and output cog assemblies includes cogs of varying diameter arranged sequentially (paragraph 26, lines 6-10). A chain 20 links one of the plurality of the input cogs 36-49 and one of the plurality of output cogs 50-63 disposed opposite the one of plurality of input cogs 36-49 for transmitting power from the input cog assembly 12 to the output cog assembly 16 (paragraph 24, line 7, FIGS. 1-7). The chain 20, in operation, has a high-tension side 66 and a low-tension side 64 (paragraph 27, lines 4-5 and FIGS. 2-6). A derailleur 26 is engageable with the low-tension side 64 of the chain 20 to laterally urge the chain 20 from a current output cog 56 to a destination output cog 57 (paragraph 27, lines 5-7). The input and output cog assemblies 12, 16 are disposed in close proximity to each other and in a complementary arrangement relative to each other with the plurality of input cogs 36-49 substantially aligned with the plurality of output cogs 50-63 in a paired arrangement (paragraph 26, lines 4-6 and FIGS. 1-7) such that in operation the high-tension side 66 of the chain 20 automatically shifts to the input cog 43 directly opposite the destination output cog 57 after the derailleur 26 laterally displaces the chain 20 from the current output cog 56 to the destination output cog 57 (paragraph 27, lines 7-10).

VI. GROUND OF REJECTION TO BE REVIEWED ON APPEAL

Whether claims 1, 3, 4, 6-10, 12, 13 and 15-18 are unpatentable over Dratewski (US 2004/0067804 A1) in view of Linde (WO 02/08050 A1) under 35 U.S.C. 103(a).

VII. ARGUMENT

Claims 1, 3, 4, 6-10, 12, 13 and 15-18 were rejected under 35 U.S.C. 103(a) as unpatentable over Dratewski (US 2004/0067804 A1) in view of Linde (WO 02/08050 A1). Examiner's rejection is improper for several reasons. Firstly, Examiner ignores clearly recited claim limitations and fabricates new claim limitations, thereby creating revised independent claims 1 and 10. Secondly, Examiner mischaracterizes the structure and function of the Dratewski device thereby creating a revised prior art device. Examiner then proceeds to combine his revised Dratewski device with Linde to invalidate his revised claims 1 and 10.

Looking to Appellant's pending independent claims 1 and 10, the following claim limitations are recited:

> an input device concentric with the output shaft and connected to the input shaft with a first flexible torque-transmitting element;
> an output device connected to the output shaft with the second flexible torque-transmitting element;

In his rejection, Examiner impermissibly transforms the above recited limitations of claims 1 and 10 as follows:

> (a) Examiner recites "an input device" but ignores its associated limitations of "concentric with the output shaft and connected to the input shaft with a first flexible torque-transmitting element."
> (b) Examiner drafts the following new limitation "the output shaft is connected to the input shaft by a first flexible torque-transmitting element and a second flexible torque-transmitting element." These features are clearly not recited in the pending claims 1 and 10.
> (c) Examiner entirely omits any mention of "an output device" and its associated limitations of "connected to the output shaft with a second flexible torque-transmitting element."

Accordingly, Examiner has not only failed to show the presence of Appellant's recited claim limitations in the prior art, but has impermissibly drafted new limitations.

Examiner has also mischaracterized the structure and function of the Dratewski device. A reference must be read for all it would have fairly taught a person having ordinary skill in the art. *In re Lamberti*, 545 F.2d 747, 750 (CCPA 1976). Examiner goes well beyond simply attempting to read the teachings of Dratewski in a new light, instead mislabeling parts and mischaracterizing the functional relationships. In doing so, Examiner creates a revised Dratewski device that does not, nor cannot work, even under his strained interpretation. Examiner's understanding of Dratewski fails primarily because he ignores the load path through the Dratewski device. In Dratewski, the load flows from input pedal assembly 76, mounted to the input drive shaft 25, to the input drive elements 38, then across one of the connection elements 42 to the output driven elements 40, mounted about the output driven shaft 27, and ultimately to output rear wheel 70 through output drive belt 80. Examiner not only ignores Appellant's recited output device and its associated limitations, but ignores the output terminal of Dratewski through belt 80 to the rear wheel 70.

Accordingly, Examiner erroneously mischaracterizes the following structures and functions of the Dratewski device:

(a) Examiner's "an input shaft (fig. 2, (27); see also [0085]);" is the output shaft 27 of Dratewski, transmitting load to the output belt 80;

(b) Examiner's "an input cog assembly ((40); see also [0086]) mounted to the input shaft, the input cog assembly including a plurality of varying diameter input cogs arranged sequentially (see [0086]);" is the output driven elements 40 mounted to the output shaft 27;

(c) Examiner's "an output shaft (fig. 2, (25); see also [0085]) disposed substantially parallel to the input shaft;" is the input shaft 25 disposed substantially parallel to the output shaft 27;

(d) Examiner's "an input device (fig. 13, (76)), the output shaft (fig. 2, (25); see also [0085] by first flexible torque-transmitting element (chain) (see fig. above) and a second flexible torque-transmitting element (drive chain) (fig. 13, (80));" is an entirely new limitation, not present in Appellant's claims 1 and 10;

(e) Examiner's "an output cog assembly ((38); see also [0086]) mounted to the output shaft, the output cog assembly including a plurality of varying diameter output cogs arranged sequentially (see [0086]);" is the input drive elements 38 mounted to the input shaft 25; and

(f) Examiner's "a chain (fig. 4, (42); see also [0080] and [0089]) linking one of the plurality of the input cogs (40) and one of the plurality of output cogs (38) disposed opposite the one of the plurality of input cogs for transmitting power from the input cog assembly ((40); see also [0086], [0088] and [0089] to the output cog assembly ((38); see also [0086], [0088] and [0089])," is a chain 42 linking one of the plurality of output driven elements 40 and one of the plurality of input drive elements 38 for transmitting power from the input drive elements 38 to the output driven elements 40.

Most notably, even in Examiner's modified Dratewski device, the mislabeled "output cog assembly 38" remains disconnected from the output belt 80 leading to the output wheel 70. Accordingly, Examiner has failed to read Dratewski for all it would have fairly taught a person having ordinary skill in the art, precisely because Examiner's modified Dratewski device does not work. Accordingly, the combination of Dratewski and Linde does not disclose all the limitations of Appellant's claims 1 and 10.

Claims 3, 4, 6-9, 12, 13 and 15-18 were also rejected under 35 U.S.C. 103(a) as being unpatentable over Dratewski in view of Linde. Since claims 3, 4, 6-9, 12, 13 and 15-18 depend directly or indirectly from and contain all the limitations of claims 1 and 10, they are felt to overcome the rejection in the same manner as claims 1 and 10.

VIII. CLAIMS APPENDIX

1. A transmission comprising:

an input shaft;

an input cog assembly mounted to the input shaft, the input cog assembly including a plurality of varying diameter input cogs arranged sequentially;

an output shaft disposed substantially parallel to the input shaft;

an input device concentric with the output shaft and connected to the input shaft with a first flexible torque-transmitting element;

an output device connected to the output shaft with a second flexible torque-transmitting element;

an output cog assembly mounted to the output shaft, the output cog assembly including a plurality of varying diameter output cogs arranged sequentially;

a chain linking one of the plurality of the input cogs and one of the plurality of output cogs disposed opposite the one of plurality of input cogs for transmitting power from the input cog assembly to the output cog assembly,

the chain, in operation, having a high-tension side and a low-tension side; and

a derailleur engageable with the low-tension side of the chain to laterally urge the chain from a current output cog to a destination output cog,

the input and output cog assemblies disposed in close proximity to each other and in a complementary arrangement relative to each other with the plurality of input cogs substantially aligned with the plurality of output cogs in a paired arrangement such that in

operation the high-tension side of the chain automatically shifts to the input cog directly opposite the destination output cog after the derailleur laterally displaces the chain from the current output cog to the destination output cog.

3. The transmission of claim 1 wherein the input device comprises a crank assembly.

4. The transmission of claim 3 further comprising a crank input cog concentric with the output shaft, and a crank output cog mounted to the input shaft, the first flexible torque-transmitting element linking the crank input cog to the crank output cog.

6. The transmission of claim 1 wherein a gear ratio is defined by a pair of input and output cogs in substantial alignment with each other.

7. The transmission of claim 1 further comprising a housing mountable to a bicycle frame for enclosing at least a portion of the transmission.

8. The transmission of claim 1 wherein the output device is a bicycle wheel, the transmission further comprising a wheel input cog mounted to the output shaft, and a wheel output cog mounted to the wheel, the second flexible torque-transmitting element linking the wheel input and output cogs.

9. The transmission of claim 8 wherein the wheel input and output cogs are in substantial alignment with each other.

10. A transmission comprising:

an input shaft;

an input cog assembly mounted to the input shaft, the input cog assembly including a plurality of input cogs;

an output shaft disposed substantially parallel to the input shaft;

an input device concentric with the output shaft and connected to the input shaft with a first flexible torque-transmitting element;

an output device connected to the output shaft with a second flexible torque-transmitting element;

an output cog assembly mounted to the output shaft, the output cog assembly including a plurality of output cogs,

one of said input and output cog assemblies comprising cogs of varying diameter arranged sequentially;

a chain linking one of the plurality of input cogs to one of the plurality of output cogs disposed opposite the one of the plurality of input cogs for transmitting power from the input cog assembly to the output cog assembly,

the chain, in operation, having a high-tension side and a low-tension side; and

a derailleur engageable with the low-tension side of the chain to laterally urge the chain from a current output cog to a destination output cog,

the input and output cog assemblies disposed in close proximity to each other and in a complementary arrangement relative to each other with the plurality of input cogs substantially aligned with the plurality of output cogs in a paired arrangement such that in operation the high-tension side of the chain automatically shifts to the input cog directly opposite the destination output cog after the derailleur laterally displaces the chain from the current output cog to the destination output cog.

12. The transmission of claim 10 wherein the input device comprises a crank assembly.

13. The transmission of claim 12 further comprising a crank input cog concentric with the output shaft, and a crank output cog mounted to the input shaft, the first flexible torque-transmitting element linking the crank input cog to the crank output cog.

15. The transmission of claim 10 wherein a gear ratio is defined by a pair of input and output cogs in substantial alignment with each other.

16. The transmission of claim 10 further comprising a housing mountable to a bicycle frame for enclosing at least a portion of the transmission.

17. The transmission of claim 10 wherein the output device is a bicycle wheel, the transmission further comprising a wheel input cog mounted to the output shaft, and a wheel output cog mounted to the wheel, the second flexible torque-transmitting element linking the wheel input and output cogs.

18. The transmission of claim 17 wherein the wheel input and output cogs are in substantial alignment with each other.

IX. EVIDENCE APPENDIX

Enclosed please find copies of the Dratewski, United States Publication No. 2004/0067804 A1, reference and the Linde, WO 02/08050 A1, reference relied upon by Examiner as to the grounds of rejection to be reviewed upon appeal.

X. RELATED PROCEEDINGS APPENDIX

None

XI. CLOSING REMARKS

For the foregoing reasons, Appellant submits that the rejection of claims 1, 3, 4, 6-10, 12, 13 and 15-18 under 35 U.S.C. 103(a) is improper, and that claims 1, 3, 4, 6-10, 12, 13 and 15-18 are, therefore, patentable. Accordingly, Appellant respectfully requests that the rejection of Examiner be reversed.

Respectfully submitted,
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Dratewski

(54) BICYCLE DRIVE TRAIN

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(21) Appl. No.: 10/249,094

(22) Filed: Mar. 15, 2003

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/065,335, filed on Oct. 4, 2002.

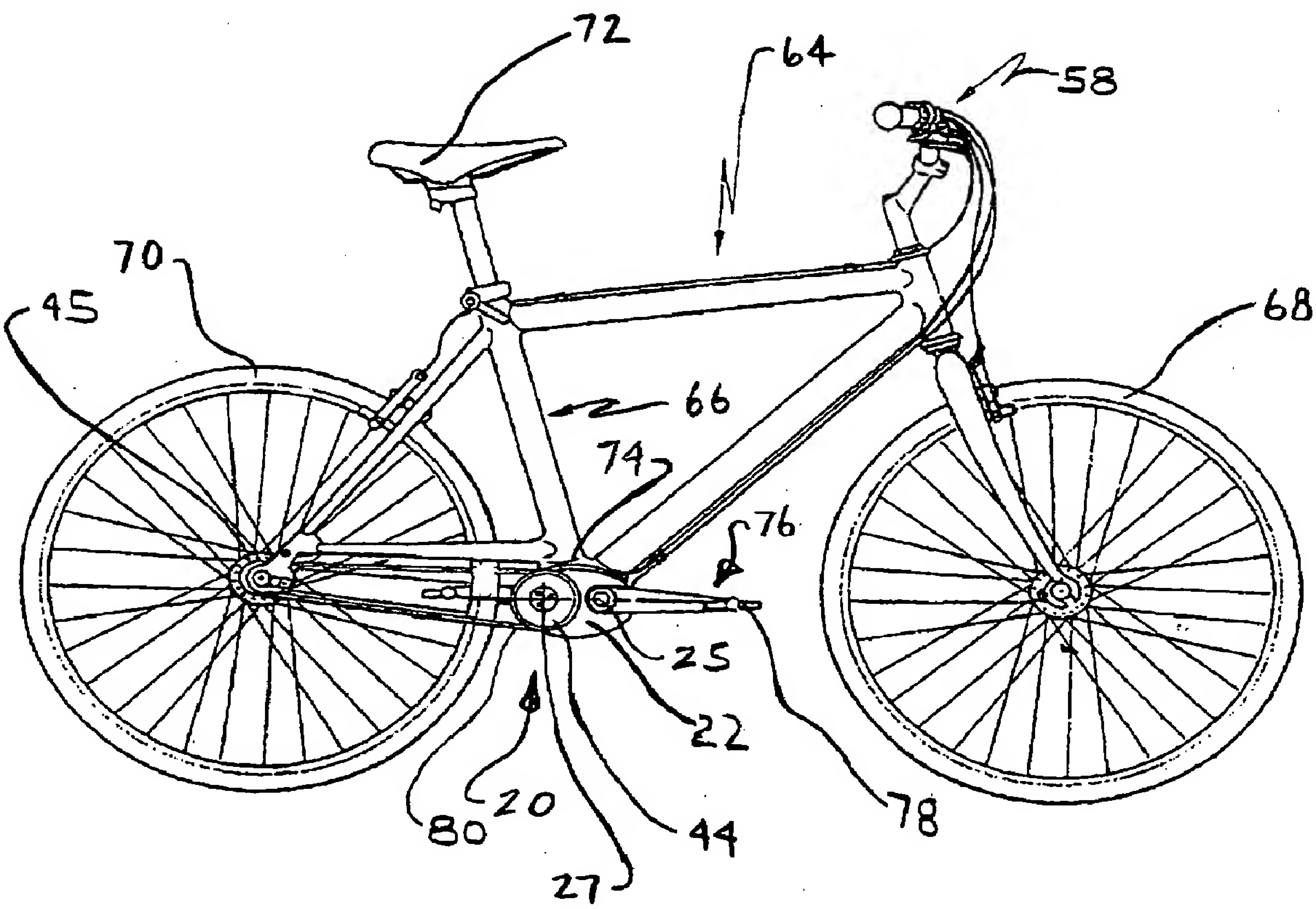
Publication Classification

(51) Int. Cl.[7] F16H 9/00; F16H 55/30

(52) U.S. Cl. 474/78; 474/81; 474/80

(57) ABSTRACT

A drive train for a bicycle includes a housing mounted in a bicycle frame with a pedal assembly attached to a drive shaft fixably mounting a plurality of different diameter drive elements, the drive shaft is journalled in and between the housing cover plates. A driven shaft is also journalled in and between the housing cover plates. The driven shaft mounts a plurality of rotatably unfixed different diameter driven elements, with the driven shaft rotationally coupled to a bicycle rear wheel. A plurality of connection elements rotationally couples the plurality of different diameter drive elements to the different diameter driven elements, wherein a single connection element rotatably couples a single drive element to a single driven element being in alignment. Also, a structural assembly for rotatably engaging a selected single driven element to the driven shaft to establish a selected rotational ratio between the drive shaft and the driven shaft.



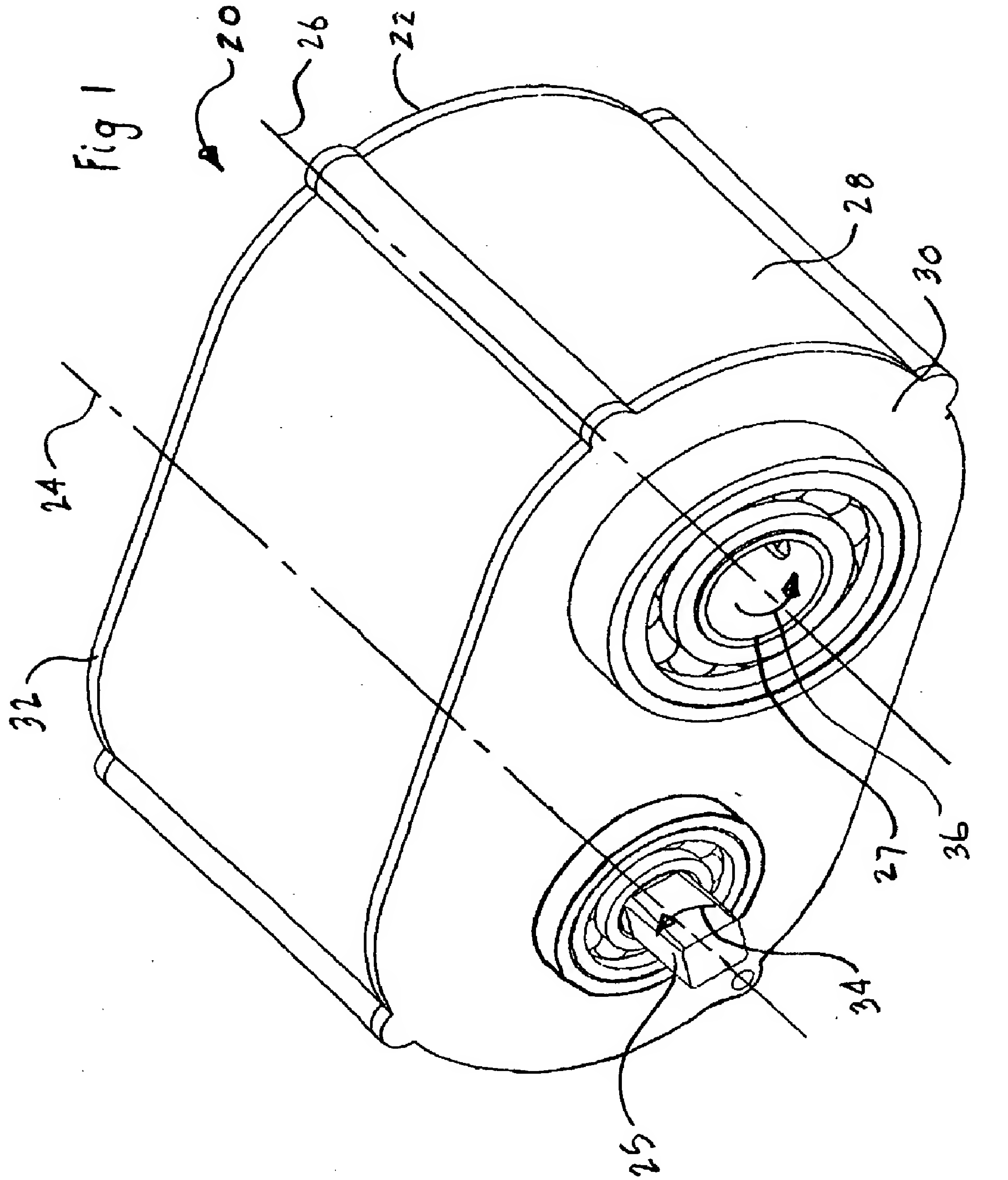
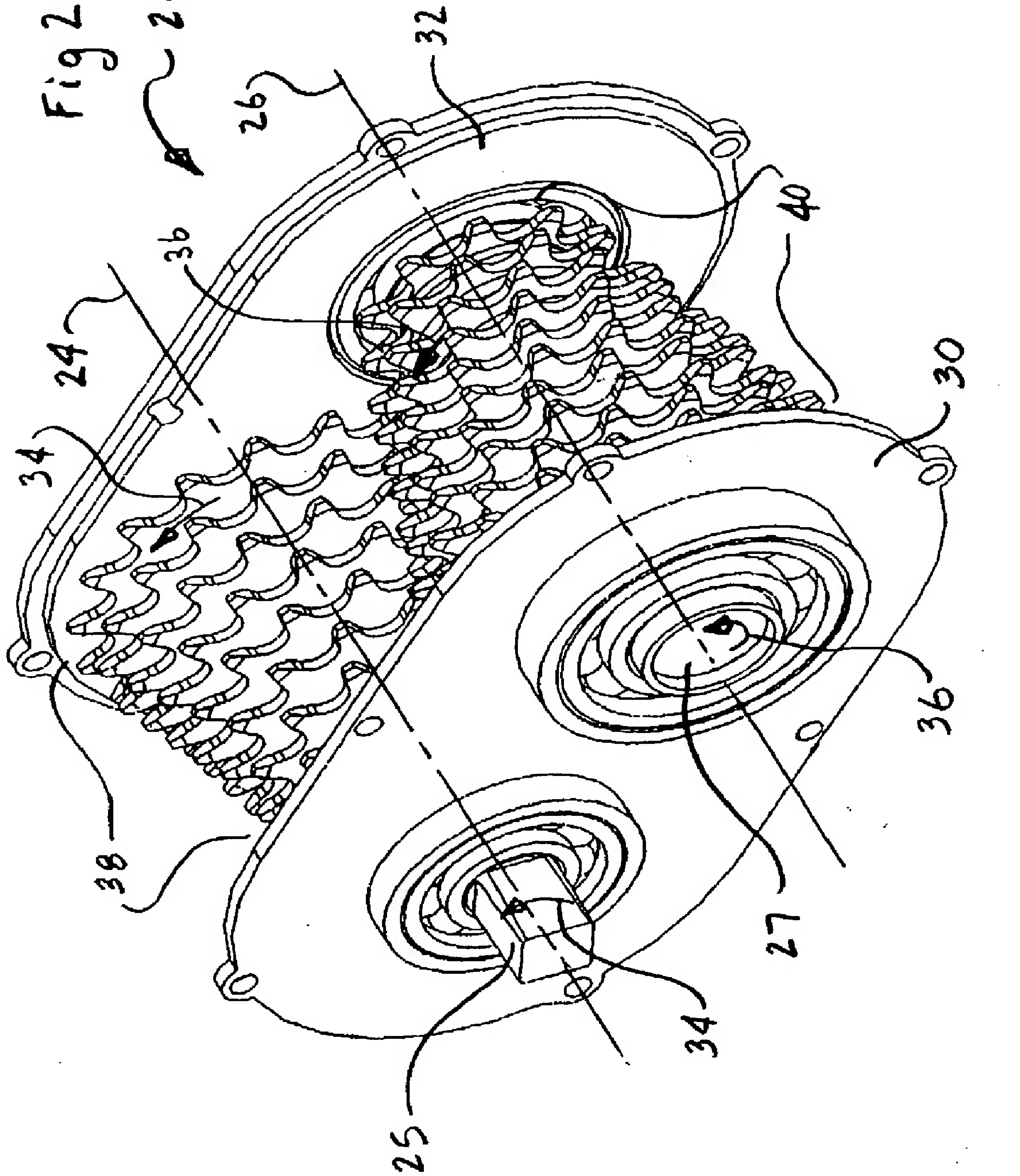


Fig 1

Fig 2



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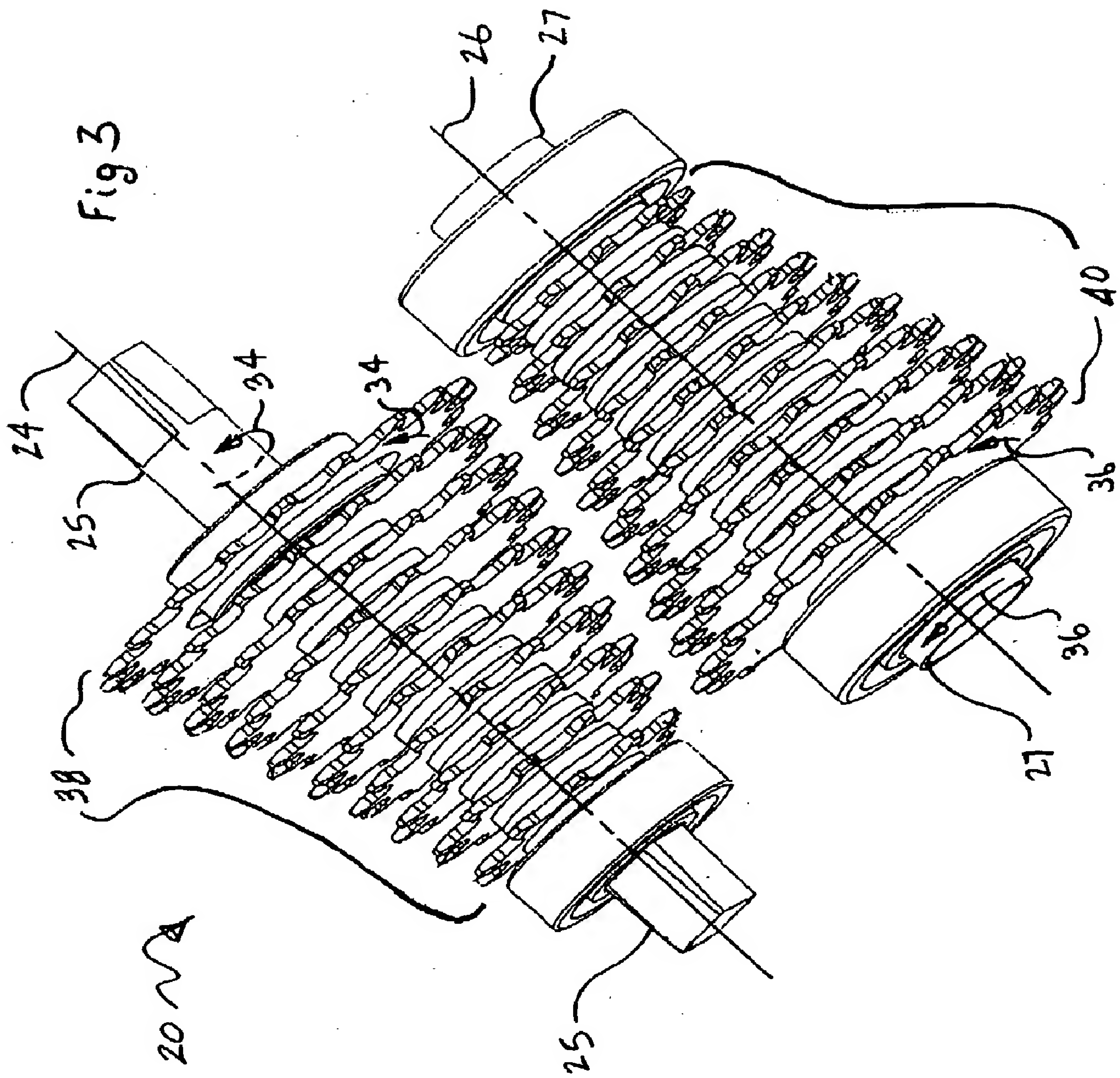
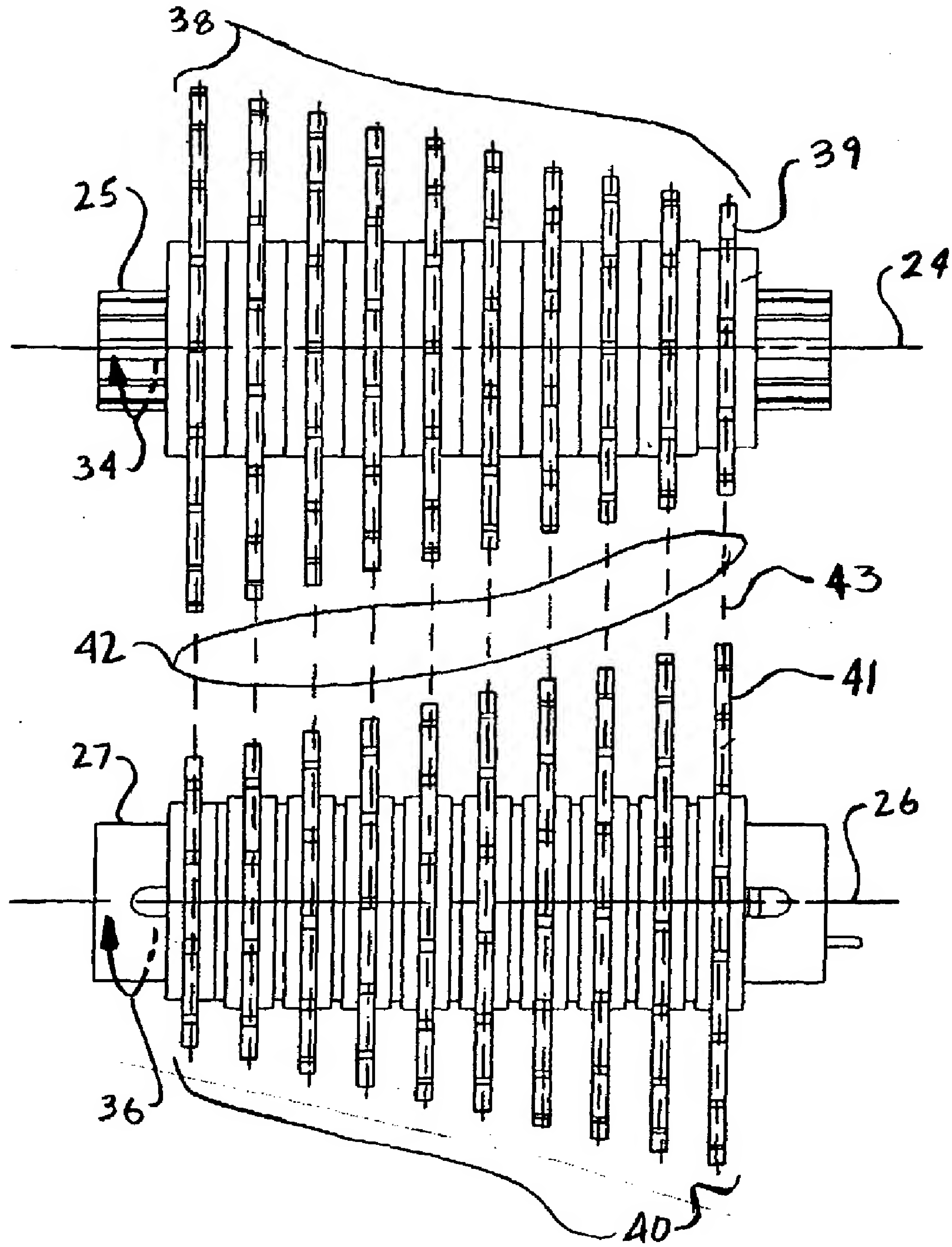


Fig 4



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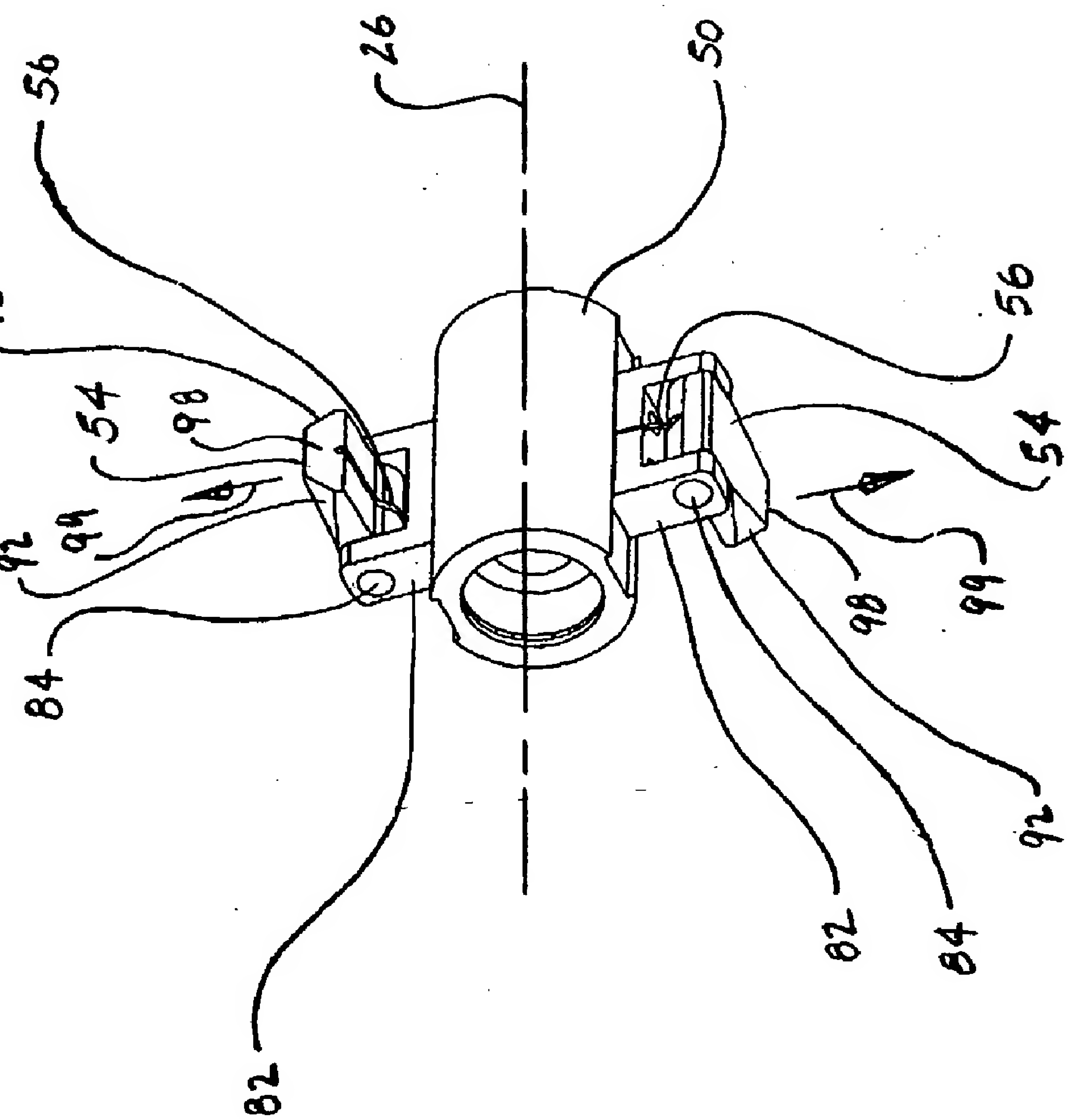


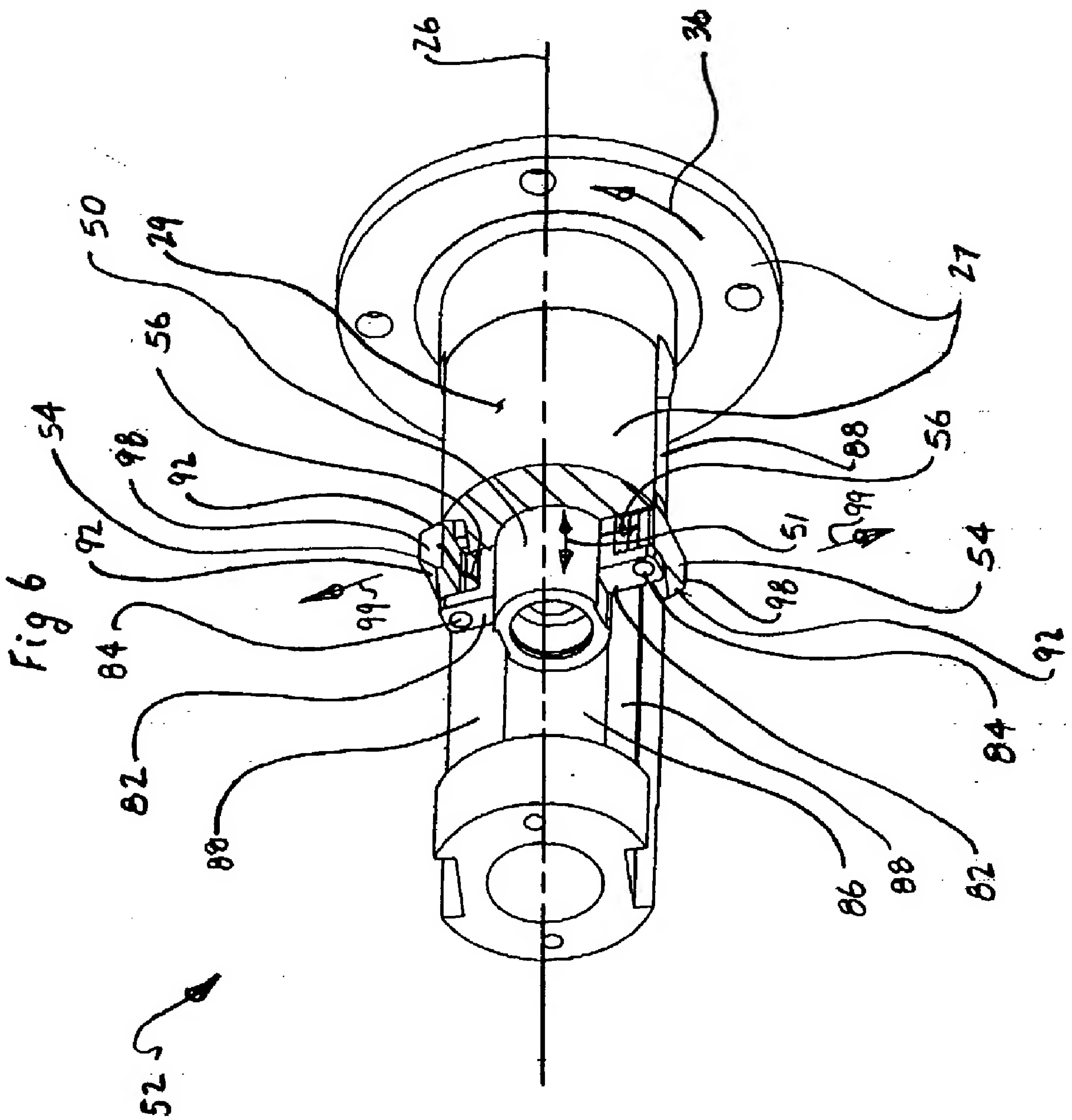
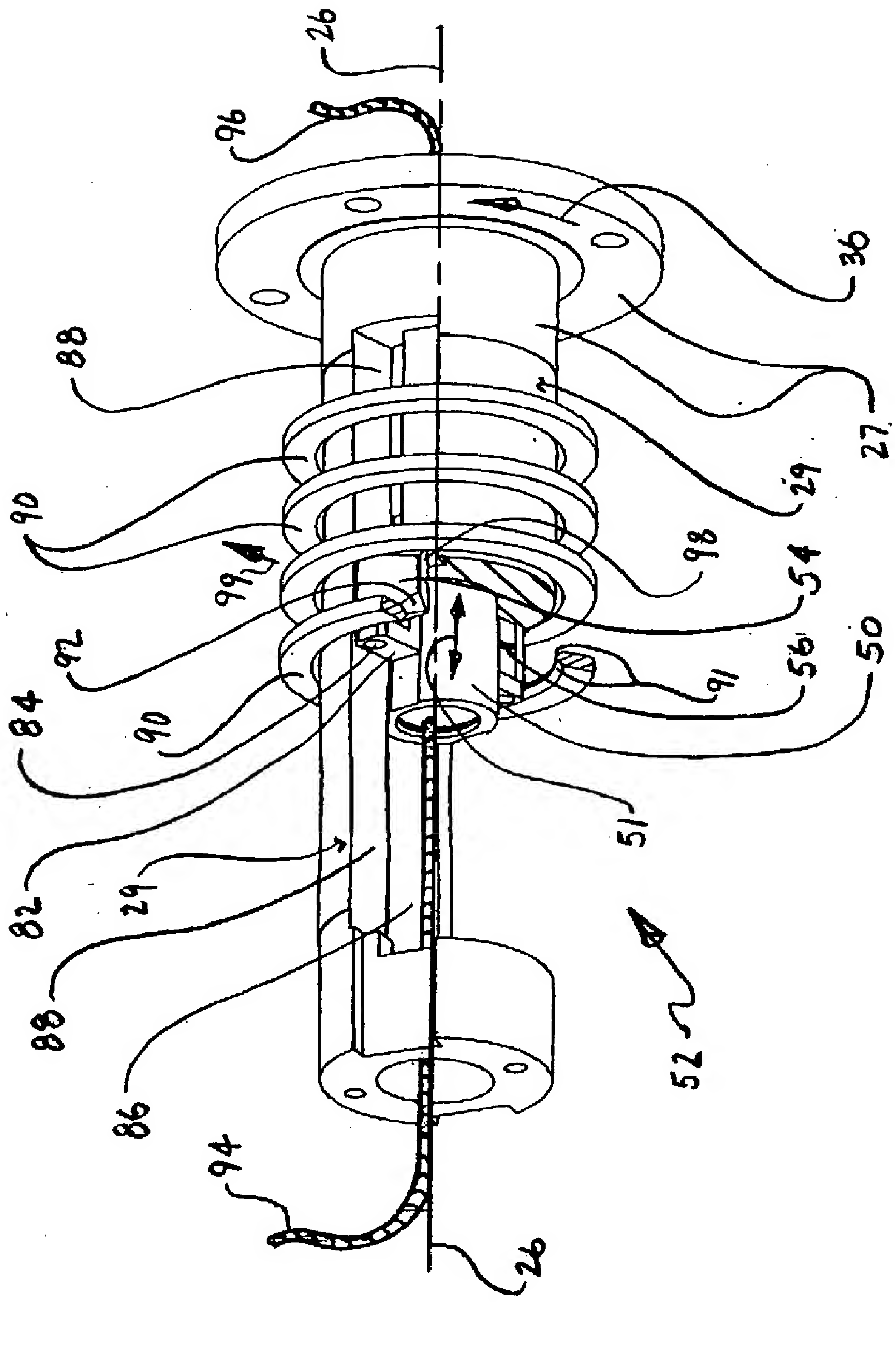


Fig 6

Fig 7



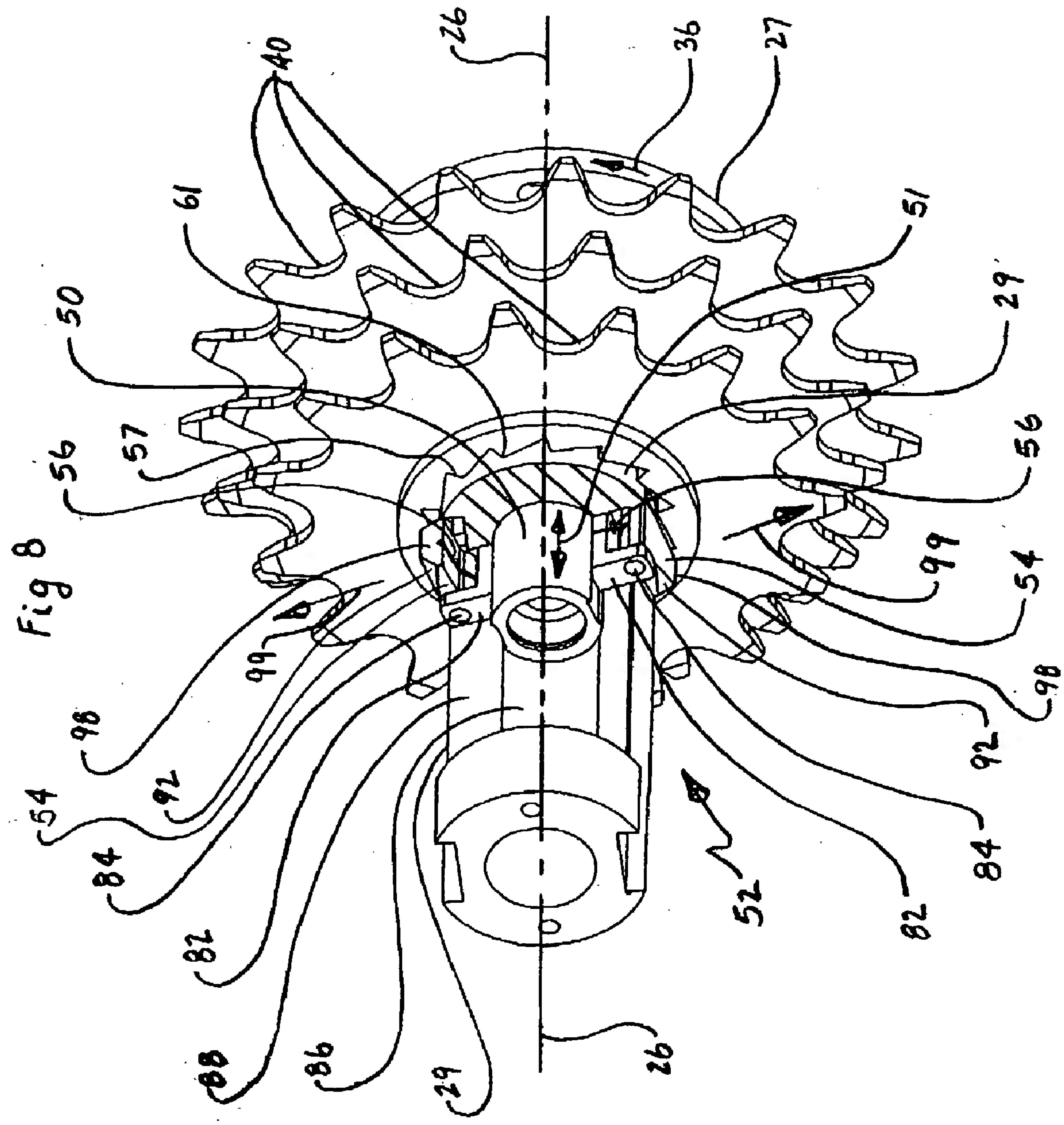

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Fig 8

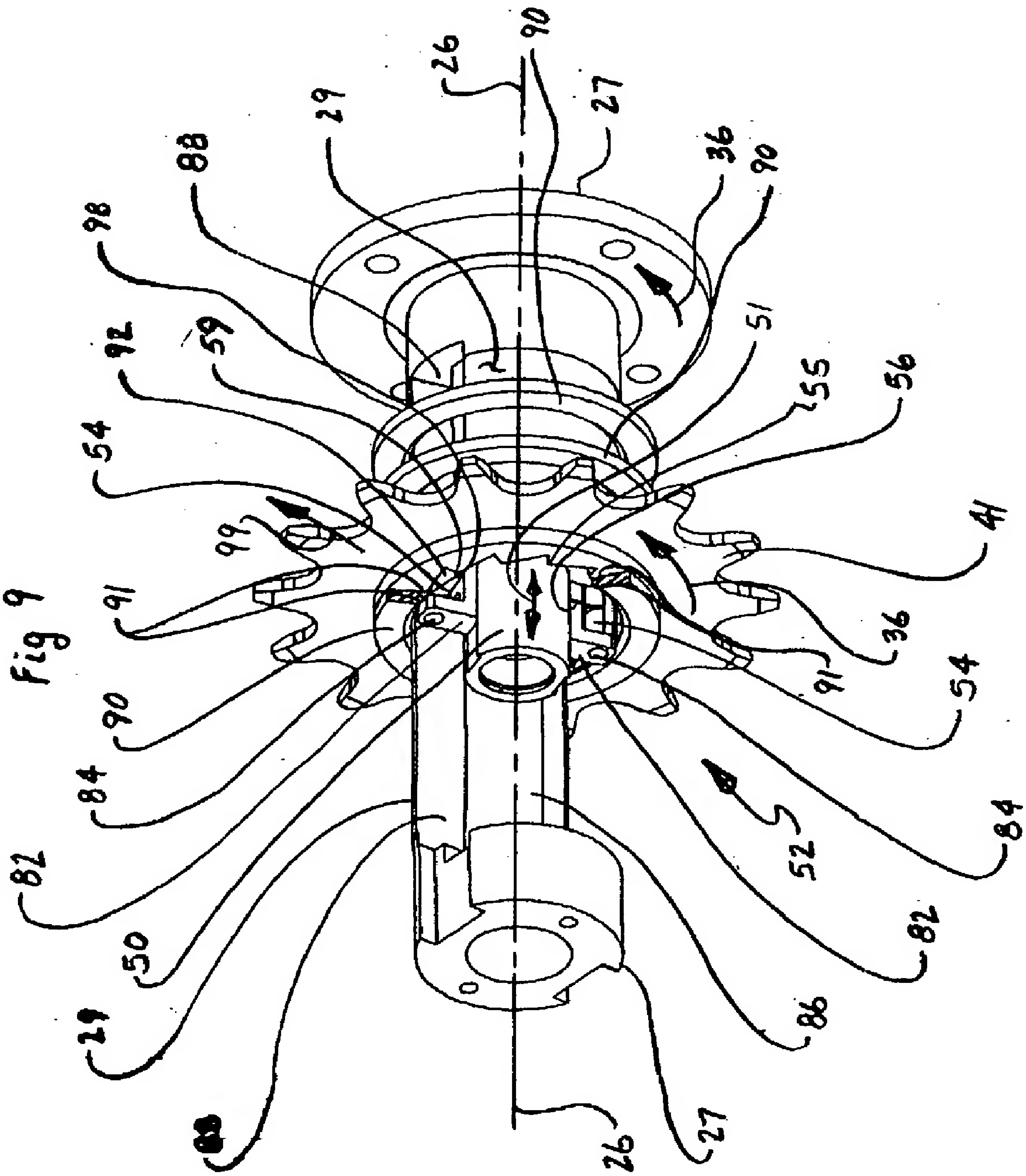
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Fig 9

Fig 11

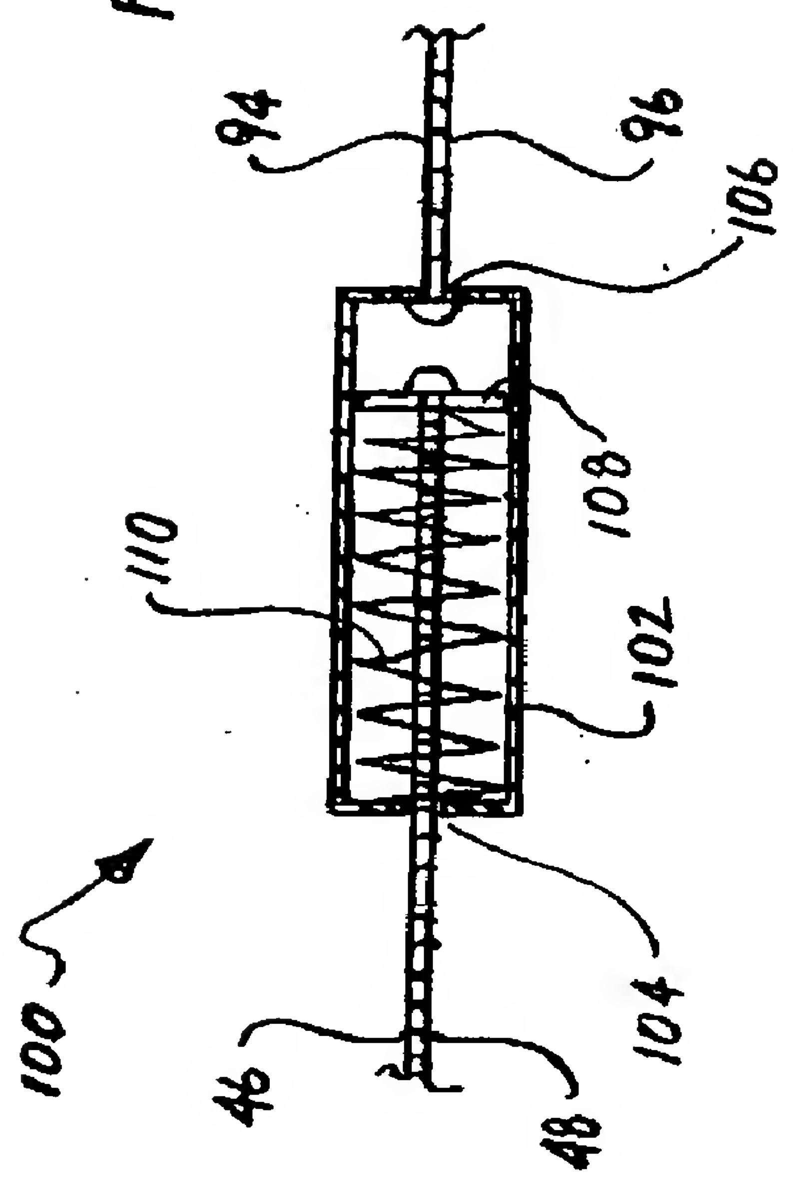
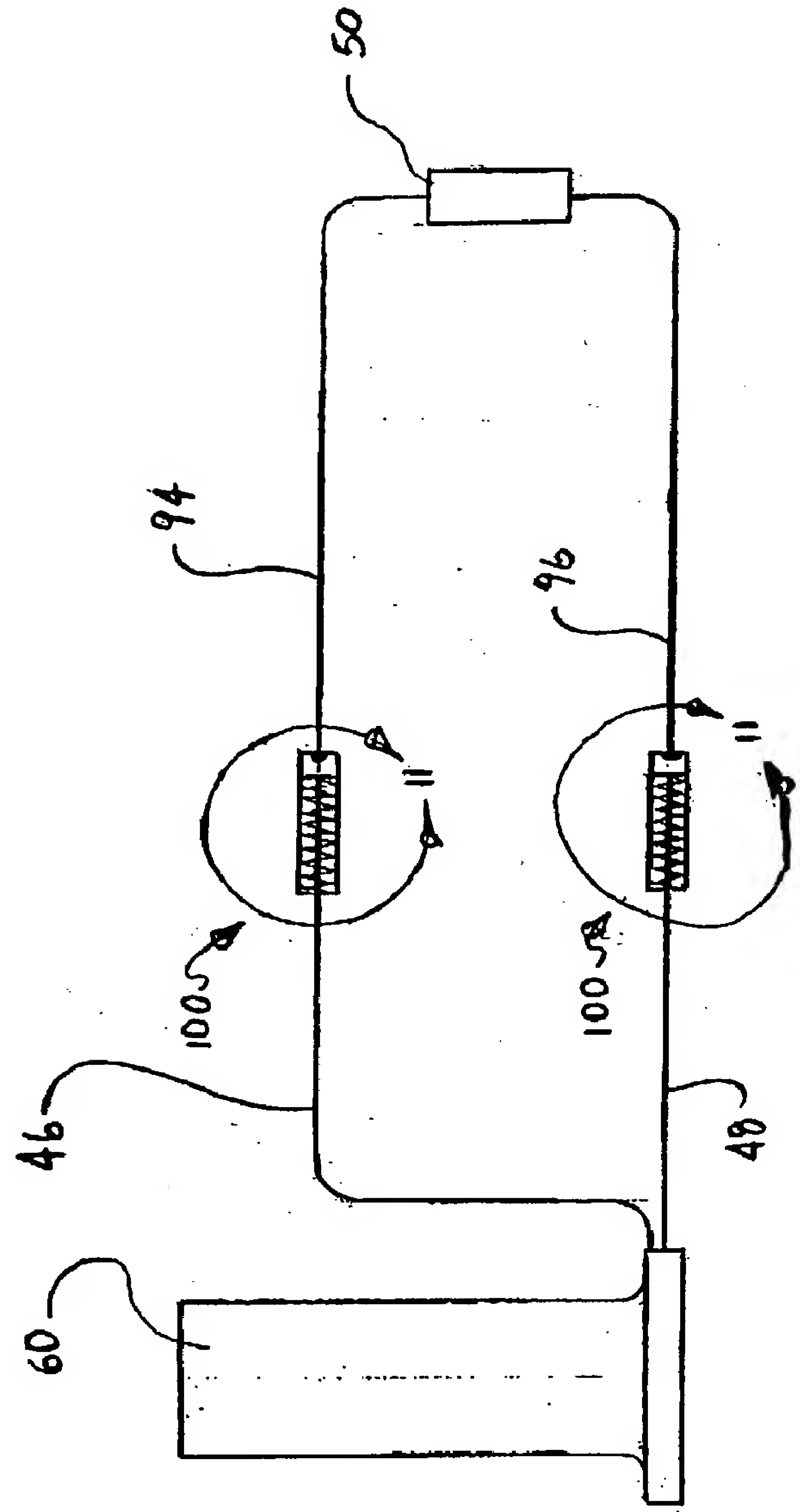


Fig 10



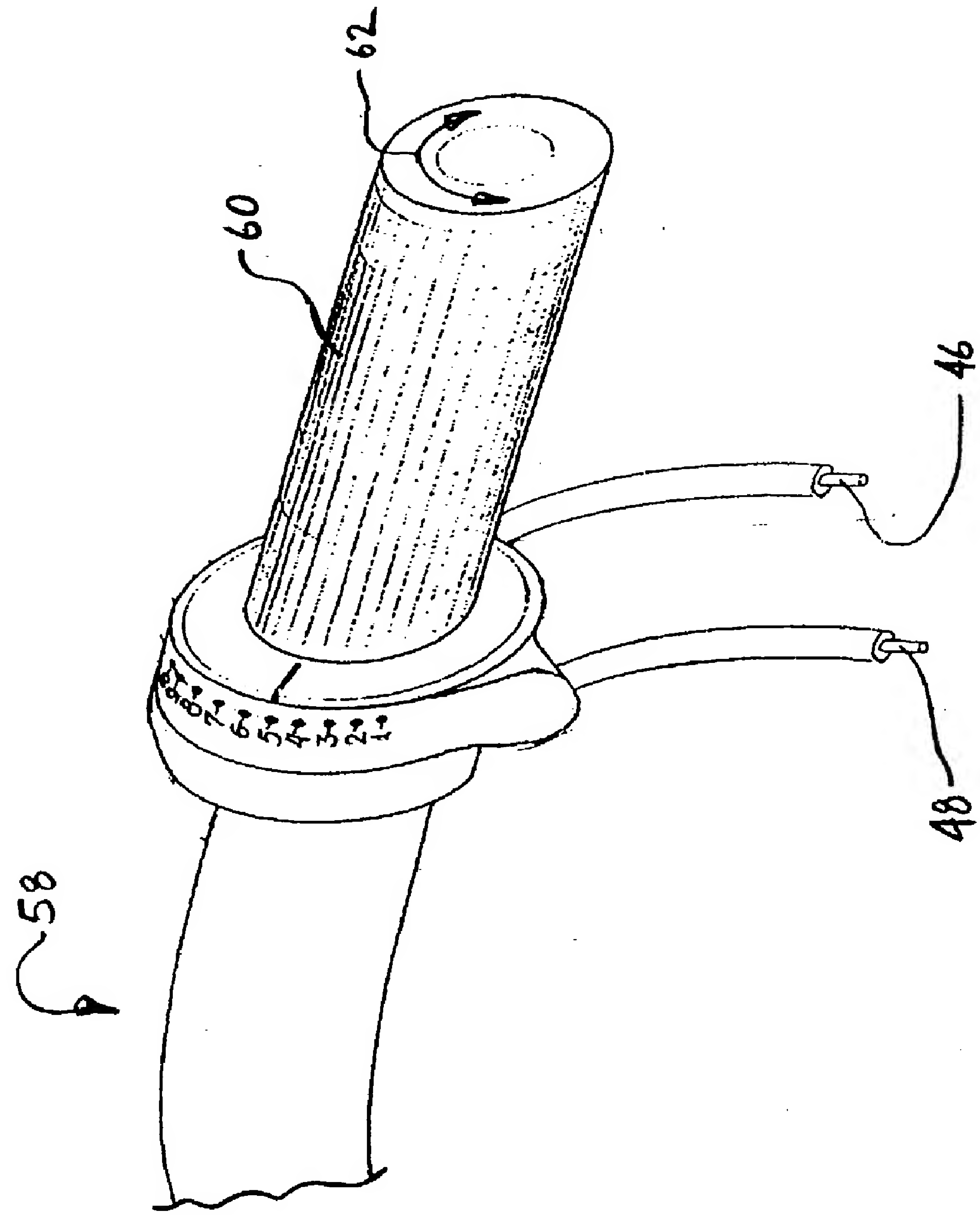
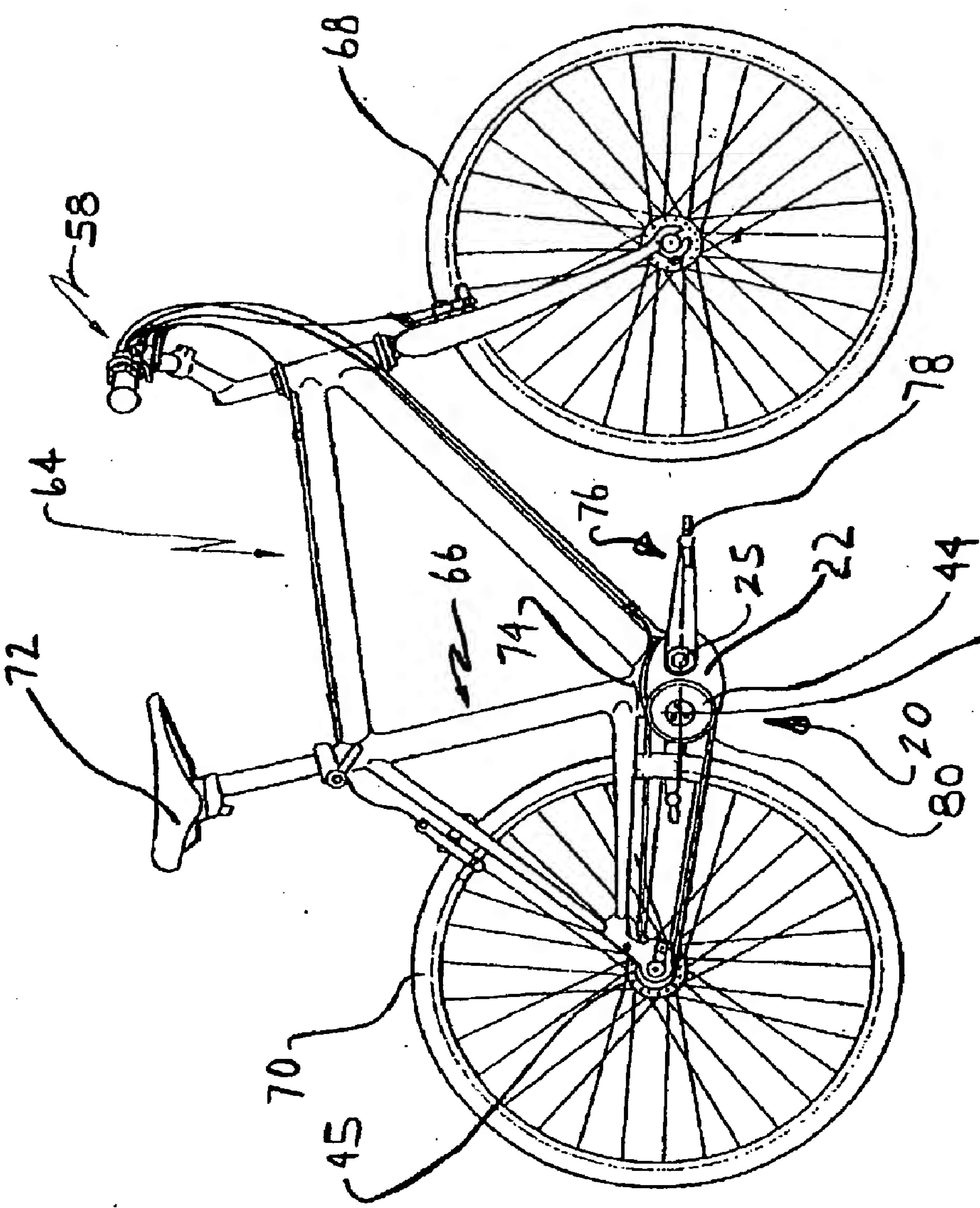


Fig 12

Fig 13



BICYCLE DRIVE TRAIN

[0001] This is a continuation in part application of U.S. patent application Ser. No. 10/065,335, filed Oct. 4, 2002 by George J. Dratewski.

TECHNICAL FIELD

[0002] The present invention relates to a mechanical drive for a bicycle, in particular, to a gear speed change apparatus for transferring rotational motion from the pedals to the rear wheel of the bicycle.

BACKGROUND OF INVENTION

[0003] Conventional bicycles utilize a sprocket and chain drive apparatus. The reasons for a sprocket and chain drive apparatus are many in a bicycle, primarily being related to minimizing the space, weight, and frictional drive train resistance that are desirable qualities of a bicycle drive apparatus. This is as compared to a conventional variable ratio gear transmission that would typically include a plurality of gears, which are selectively inner meshed to provide variable speed transformation through changing gear ratios. However, this conventional type of gear transmission tends to be large, heavy, having high frictional losses, and is mechanically complex which are undesirable attributes for a bicycle drive train apparatus.

[0004] The conventional bicycle drive train apparatus generally includes two shift levers or grip shifts connected to front and rear derailleur mechanisms. The major drawbacks of the aforementioned sprocket and chain drive apparatus are that changing gears requires the use of two controls (grip shifts or levers), one for the front sprocket set and one for the rear derailleur sprocket set. In many instances, changing gears or speeds is not a smooth operation due to the chain jumping up and down across the multiple sprockets. The chain can even jump completely off of the sprocket if not operated carefully and smoothly enough. Also, selecting a speed is confusing because not everyone understands that although twenty-one speeds are typically theoretically possible, not all combinations of the front and rear sprockets are practical to use. A typical bicycle has three front sprockets and seven rear sprockets, theoretically providing twenty-one gears if all combinations of front and rear sprockets are used. In reality, each front sprocket only provides a useable gear combination with three to four of the positions of the rear sprocket, resulting in nine to twelve usable gears. Combinations of the extreme angular position of front and rear sprocket alignment forces the chain to work in an undesirable diagonal or angular position. The chain is not designed to work in this illogical position or gear combination as chains have very little sideways flexibility with the chain possibly seeking to switch itself to the more logical position thus minimizing the chain's sideways angularity.

[0005] Additionally, the chain itself presents many inherent problems. Its oil attracts dust and spreads oil on to the bicycle frame and occasionally on to the legs of the bicycle rider. If the chain is dry, in other words devoid of oil, it will not operate properly and will be prone to making noise, and experiencing excessive wear including a high degree of frictional resistance while in use by the bicycle rider. Another problem is in replacing the chain, which cannot be removed from the bicycle without the use of special tools or to actually break the chain. Plus, derailleurs suffer from their complexity. They are delicate, difficult to adjust, and are easy to bend or be damaged. This is especially true for the rear derailleur, which may protrude very low on the bicycle, and other words being close to the riding surface or ground. Once it is bent, it is very difficult to adjust or repair. Another issue is in, attaching and removing the rear wheel, which is both complicated and dirty. A lot of work can and quite a bit of knowledge are required to do it correctly, and it is nearly impossible to do without getting substantial amounts of grease on one's hands. Finally, it is problematic for the rider to change gears effectively enough to go from level pavement to a hill or from a very fast speed to a slower speed. On the conventional prior art bicycle drive train apparatus the rider must change both the front and rear years, going through every gear in between. Thus, it is impossible to switch directly and smoothly from fast to slow without going through the gears in between.

[0006] Prior art solutions to the aforementioned problems are disclosed in U.S. Pat. No. 4,697,469 to Takamiya et al. and U.S. Pat. No. 5,971,877 to Hunter, Jr. et al. that attempt to solve the issues of multiple sprocket derailleurs by using an enclosed assembly of a plurality of pawls that engaged to a driving internally toothed ratchet on the outermost extremity of the pawl, with the pawl attached to a driven rotary body on the innermost extremity of the pawl. A variable gear ratio between the driving and driven elements is achieved by the driven rotary body having an adjustable eccentric positional relationship with the driving internally toothed ratchet. This causes the engagement between the internally toothed ratchet and the outermost extremity of the pawl to only occur through a limited angular segment of the circumference of rotation, sometimes called the driving zone of which is approximately 60 degrees. Although, Takamiya et al. and Hunter, Jr et al. do manage to dispose of multiple sprockets, chain angularity, and shifting problems, the pawl eccentric arrangement does have its own limitations and problems with a limited gear ratio differential, in other words the change in minimum to maximum gear ratio is limited due to the mechanical positioning of the pawl length and angularity in relation to the amount of eccentric position between the driving and driven elements. In addition, under heavy or high load use the pawls outmost extremities can wear where they engage with the internally toothed ratchet causing slippage between the driving and driven elements.

[0007] Another series of prior art solutions to the aforementioned problems, although not specifically designed for bicycle drive train applications are given in U.S. Pat. No. 6,146,296 to Apostolo, U.S. Pat. No. 5,871,412 to Moser, and U.S. Pat. No. 4,158,316 to Strong, wherein these three identified prior art patents utilize a series of different size pulleys or sprockets that are co-axially located and fixed on a first common shaft that are parallel to another series of different sized pulleys or sprockets not affixed to a second common shaft that have an inverse relationship in that a large diameter pulley sprocket is aligned with a small diameter pulley sprocket wherein the aligned set of pulleys or sprockets are connected by a belt or a chain respectively. Different drive gear ratios are achieved by the interface between the second common shaft and its associated pulleys or sprockets being selectively rotationally engaged on an individual pulley or sprocket basis, thus allowing only one set of pulleys or sprockets to actually transmit rotational power between the first common shaft and the second common shaft at any one time. Again, this type of system

eliminates the previously mentioned chain angularity problem, however, there is a drawback of the added complexity of the selective engagement system between an individual pulley or sprocket and shaft, also sometimes the size or space requirements of this type of variable ratio drive system are undesirable.

[0008] What is needed is a bicycle drive train apparatus that is light in weight, smaller in size, has low frictional resistance, and not having any the aforementioned to problems that exist in the prior art. This would dictate that a chain and sprocket system be used to effectuate high efficiency or low loss power transmission on a bicycle, however, without imparting any angularity into the chain alignment thus requiring that the drive sprockets remain in alignment during use, while it the same time achieving a wide range of different gear ratios.

SUMMARY OF INVENTION

[0009] The present invention of a drive train for bicycles includes a housing assembly that is mounted at a lower middle junction of the bicycle frame, which has a pedal assembly journalled therein. The pedal assembly includes a drive shaft that fixably mounts a plurality of different diameter drive elements coaxially. The drive shaft has a drive shaft rotational axis and is journalled in and between a housing first end cover plate and a housing second end cover plate of the housing assembly. The drive elements have a generally conical envelope extending between the housing first end cover plate and the housing second end cover plate of the housing assembly. Also included, is a driven shaft that is journalled in and between the housing first end cover plate and the housing second end cover plate of the housing assembly. The driven shaft has a driven shaft rotational axis positioned parallel to the drive shaft rotational axis. The driven shaft mounts a plurality of rotatably unfixed different diameter driven elements coaxially. The driven elements have a generally conical envelope extending between the housing first end cover plate and the housing second end cover plate of the housing assembly, with the driven shaft rotationally coupled to a bicycle rear wheel.

[0010] In addition, the drive train for bicycles includes a plurality of connection elements for rotationally coupling the plurality of different diameter drive elements to the different diameter driven elements such that a single connection element rotatably couples a single drive element to a single driven element that are in alignment. Also, a means for rotatably engaging a selected single driven element to the driven shaft is operational to establish a selected rotational ratio between the drive shaft and the driven shaft.

[0011] These and other objects of the present invention will become more readily appreciated and understood from a consideration of the following detailed description of the exemplary embodiments of the present invention when taken together with the accompanying drawings, in which;

BRIEF DESCRIPTION OF DRAWINGS

[0012] **FIG. 1** is a perspective view of the bicycle drive train assembly in its entire housing;

[0013] **FIG. 2** is a perspective view of the bicycle drive train assembly with a central body shell of the housing removed;

[0014] **FIG. 3** is a perspective view of the bicycle drive train assembly with the entire housing assembly removed that includes the central body shell and a first end cover plate and a second end cover plate;

[0015] **FIG. 4** shows a central body view of the drive element and driven element alignment between the drive shaft and the driven shaft;

[0016] **FIG. 5** shows a perspective view of an axially slidable body with a plurality of pivotal fingers and a means for biasing the pivotal fingers towards a single selected driven element cavity (not shown);

[0017] **FIG. 6** shows a perspective view of a portion of the driven shaft assembly with the axially slidable body located within the driven shaft void;

[0018] **FIG. 7** shows a perspective view of a portion of the driven shaft assembly with the axially slidable body located within the driven shaft void, also shown are a pair of control cables adjacent to the axially slidable body and a plurality of transition elements;

[0019] **FIG. 8** shows a perspective view of a portion of the driven shaft assembly with the axially slidable body located within the driven shaft void and the plurality of different diameter driven elements;

[0020] **FIG. 9** shows a perspective view of a portion of the driven shaft assembly with the axially slidable body located within the driven shaft void, with the axially slidable body rotationally engaged to a selected single driven element, thus rotationally affixing or engaging the selected single driven element and the driven shaft in addition to the transition elements being shown;

[0021] **FIG. 10** shows a flat layout view of the handlebar mounted selector for the bicycle rider selected drive train transmission ratios in conjunction with the cable tensioning assemblies and the axially slidable body;

[0022] **FIG. 11** shows an expanded view of the cable tensioning assembly;

[0023] **FIG. 12** shows a perspective view of the handlebar mounted selector for bicycle rider selected drive train transmission ratios; and

[0024] **FIG. 13** shows a side elevation view of a bicycle incorporating the present invention of the bicycle drive train.

REFERENCE NUMBER IN DRAWINGS

[0025] **20** Bicycle drive train assembly

[0026] **22** Housing assembly

[0027] **24** Drive shaft rotational axis

[0028] **25** Drive shaft

[0029] **26** Driven shaft rotational axis

[0030] **27** Driven shaft

[0031] **28** Housing central body shell

[0032] **29** Driven shaft outside diameter

[0033] **30** Housing first end cover plate

[0034] **32** Housing second end cover plate

[0035] **34** Drive shaft rotational direction

[0036] 36 Driven shaft rotational direction

[0037] 38 Plurality of different diameter drive elements

[0038] 39 Single drive element

[0039] 40 Plurality of different diameter driven elements

[0040] 41 Selected single driven element

[0041] 42 Plurality of connection elements

[0042] 43 Single connection element

[0043] 44 Drive toothed wheel

[0044] 45 Driven toothed wheel

[0045] 46 Direct acting control cable

[0046] 48 Reverse acting control cable

[0047] 50 Axially slidable body

[0048] 51 Body axial movement

[0049] 52 Means for rotatably engaging a selected single driven element to the driven shaft

[0050] 54 Pivotal finger

[0051] 55 Internal diameter of selected single driven element

[0052] 56 Means for biasing pivotal finger toward single selected driven element cavity

[0053] 57 Driven element cavities

[0054] 58 Handlebar assembly

[0055] 59 Selected single driven element cavity

[0056] 60 Handlebar mounted selector

[0057] 61 Internal diameter of driven elements

[0058] 62 Handle rotation

[0059] 64 Bicycle

[0060] 66 Bicycle frame

[0061] 68 Bicycle front wheel

[0062] 70 Bicycle rear wheel

[0063] 72 Bicycle seat

[0064] 74 Lower middle junction of bicycle frame

[0065] 76 Bicycle pedal assembly

[0066] 78 Bicycle pedal

[0067] 80 Final drive belt or chain

[0068] 82 Bracket for pivotal finger

[0069] 84 Pivot pin for pivotal finger

[0070] 86 Driven shaft void

[0071] 88 Driven shaft axial slot

[0072] 90 Transition element

[0073] 91 Transition element internal diameter bevel

[0074] 92 Pivotal finger bevel

[0075] 94 Coupled direct acting control cable

[0076] 96 Coupled reverse acting control cable

[0077] 98 Pivotal finger drive face

[0078] 99 Pivotal finger biasing direction

[0079] 100 Cable tensioner assembly

[0080] 102 Cable tensioner housing

[0081] 104 Cable slip fit in cable tensioner housing

[0082] 106 Cable attachment to cable tensioner housing

[0083] 108 Retainer for means for controlling cable tension

[0084] 110 Means for controlling cable axial tension

DETAILED DESCRIPTION

[0085] With initial reference to **FIG. 1** shown is a perspective view of the complete bicycle drive train assembly **20**. A drive shaft rotational axis **24** and a driven shaft rotational axis **26** are shown to be positioned parallel to one another. A drive shaft **25** rotates about the drive shaft rotational axis **24** in a drive shaft rotational direction **34** being coincident with a driven shaft **27** that rotates about the driven shaft rotational axis **26** in a driven shaft rotational direction **36**. Also shown is the housing assembly **22** that comprises a housing central body shell **28** and a housing first end cover plate **30** and a housing second end cover plate **32**. The drive shaft **25** is journalled in and between the housing first end cover plate **30** and the housing second end cover plate **32** of the housing assembly **22.** Likewise, the driven shaft **27** is journalled in and between the housing first end cover plate **30** and the housing second end cover plate **32** of the housing assembly **22**. It is preferred that the drive shaft **25** and the driven shaft **27** that are both journalled in and between the housing first end cover plate **30** and the housing second end cover plate **32** be rotationally mounted as shown with the use of conventional ball bearings. However, other types of bearings would also be acceptable, such as roller bearings, sleeve bearings, or any other type of bearing that would meet the conditions required for operation of the bicycle drive train assembly **20**.

[0086] Moving next to **FIG. 2** shown is a perspective view of the bicycle drive train assembly **20** as shown in **FIG. 1** with the central body shell **28** of the housing assembly **22** removed to show a plurality of different diameter drive elements **38** and a plurality of different diameter driven elements **40**. As described in **FIG. 1** the drive shaft rotational axis **24** and the driven shaft rotational axis **26** are shown to be positioned parallel to one another. The drive shaft **25** rotates about the drive shaft rotational axis **24** in the drive shaft rotational direction **34** being coincident with the driven shaft **27** that rotates about the driven shaft rotational axis **26** in the driven shaft rotational direction **36**. Also shown is a portion of the housing assembly **22** with the housing first end cover plate **30** and the housing second end cover plate **32**. The drive shaft **25** is journalled in and between the housing first end cover plate **30** and the housing second end cover plate **32** of the housing assembly **22.** Likewise, the driven shaft **27** is journalled in and between the housing first end cover plate **30** and the housing second end cover plate **32**. It can also be seen that both the plurality of different diameter drive elements **38** and the plurality of different diameter driven elements **40** have a generally

inverse conical envelope relationship that extends between the housing first end cover plate **30** and the housing second in cover plate **32**.

[0087] Further, to **FIG. 3** shown is a perspective view of the bicycle drive train assembly **20** with the entire housing assembly **22** removed. Paying particular attention to the drive shaft **25** there are fixably mounted a plurality of different diameter drive elements **38** that are co-axially positioned about the drive shaft rotational axis **24**, also indicated is the drive shaft rotational direction **34**. Again, likewise the driven shaft **27** mounts a plurality of rotatably unfixed different diameter driven elements **40** that are co-axially positioned about the driven shaft rotational axis **26**, also indicated is the driven shaft rotational direction **36**.

[0088] Next, to **FIG. 4** shown is a central body view of the alignment between the plurality of different diameter drive elements **38** and the plurality of different diameter driven elements **40** respectively mounted upon the drive shaft **25** and the driven shaft **27** with the attendant drive shaft rotational axis **24** and drive shaft rotational direction **34** and the driven shaft rotational axis **26** and the driven shaft rotational direction **36** as previously described. The alignment between the plurality of different diameter drive elements **38** and the plurality of different diameter driven elements **40** is shown with a plurality of connection elements **42** there used for rotationally coupling the plurality of different diameter drive elements **38** to the plurality of different diameter driven elements **40**. Thus, the plurality of connection elements **42** is such that a single connection element **43** rotatably couples a single drive element **39** to a single driven element **41** that are in alignment to enable the transfer of rotational motion from the plurality of different diameter drive elements **38** to the plurality of different diameter and driven elements **40**.

[0089] Preferably, the plurality of different diameter drive elements **38** are constructed of chain sprockets as well as the plurality of different diameter driven elements **40** also being constructed of chain sprockets. In accordance with this, the plurality of connection elements **42** would preferably be constructed of a plurality of chain drive loops **42** rotationally coupling the plurality of different diameter drive chain sprockets **38** to the plurality of different diameter driven chain sprockets **40**. Again, the plurality of connection elements **42** that would be constructed of a plurality of chain drive loops is such that a single chain drive loop **43** rotatably couples a single drive chain sprocket **39** to a single driven chain sprocket **41** that are in alignment to enable the transfer of rotational motion from the plurality of different diameter drive chain sprockets **38** to the plurality of different diameter and driven chain sprockets **40**. Alternatively, the plurality of connection elements **42** could be belts or toothed belts that would matingly engage the plurality of different diameter drive elements **38** to the plurality of different diameter and driven elements **40** with the plurality of different diameter drive elements **38** and the plurality of different diameter and driven elements **40** accommodating the aforementioned belts.

[0090] The following is a comparison of the prior art bicycle drive train ratio versus the present invention drive train ratio.

[0091] The total gear ratio of a typical prior art mountain bike can be calculated as follows;

[0092] Rear sprocket-smallest-11 teeth

[0093] Rear sprocket-biggest-28 teeth

[0094] Front sprocket-smallest-24 teeth

[0095] Front sprocket-biggest-38 teeth

[0096] Fast driving ratio=38/11=3.450

[0097] Slow driving ratio=24/28=0.857

[0098] Total ratio=3.450/0.857=4

[0099] Referring to the present invention as an example, the plurality, **10** for example, different diameter drive chain sprockets **38** and the plurality, again **10** for example, of different diameter driven chain sprockets **40**, that would result in a **10** speed gearbox, the largest single drive or driven element is twice the diameter of the smallest single drive or driven element. In this case, the overall gear ratio on the present invention can be calculated as follows;

Fast driving ratio=2/1=2

Slow driving ratio=1/2=0.5

Total ratio=2/0.5=4

[0100] Thus, the total gear ratio of the present invention is equal to the total gear ratio of a typical prior art mountain bike, however, any number of deviations for the total ratio and/or number of drive and driven elements of the present invention are possible depending upon the bicycle rider, the bicycle type, and the terrain ridden upon.

[0101] Next, referring to **FIG. 5** shown is a perspective view of the axially slidable body **50** in relation to the driven shaft rotational axis **26** with a pivotal finger **54** or alternatively a plurality of pivotal fingers **54** being biased in direction **99** about the pivot pin **84**. The pivotal finger **54** is shown in position from a means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown), or in other words in direction **99**. Alternatively, a plurality of means **56** for biasing the pivotal finger **54** could be utilized with a plurality of pivotal fingers **54**. The body **50** can be operational as previously described with a single pivotal finger **54**. However, it is preferred that the body **50** utilizes a plurality of fingers **54** and their associated plurality of means **56** for biasing the pivotal finger **54**. In addition, the plurality of fingers **54** will allow for a higher torque transmission between a selected single driven element (not shown) and the driven shaft **27** (not shown). The pivotal finger **54** also has a drive face **98** that engages the single selected driven element cavity (not shown) and a bevel **92** to ease the axial movement of the pivotal finger **54** between selected driven element cavities (not shown). Note, that there is also shown a pivotal finger **54** bracket **82** that supports a pivot pin **84** for the pivotal finger **54** to pivot about, wherein the bracket **82** is attached in any conventional manner to the axially slidable body **50**, such as by welding, tongue and groove, dove tail, use of fasteners, and the like. However, the bracket **82** and the axially slidable body **50** could also be integral elements. Means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) could be simply the use of centrifugal force from the rotation **36** (not shown) of the driven shaft **27** (not shown). Also, the means **56** could be any number of configurations such as a leaf spring, wave spring,

coil spring, rubber block, torsional rod pivot pin, and the like for accomplishing the bias of the finger **54** in direction **99** about the pivot pin **84**.

[0102] Further, looking to **FIG. 6** shown is a perspective view of the structural assembly or means **52** for rotatably engaging a selected single driven element (not shown) to the driven shaft **27**. The means **52** includes the axially slidable body **50** that is within a driven shaft void **86**, with axial movement denoted by **51** in relation to the driven shaft rotational axis **26** with a pivotal finger **54**, or alternatively a plurality of pivotal fingers **54** being biased in direction **99** about the pivot pin **84** in bracket **82** by the means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) which is in direction **99**. The pivotal finger **54** is shown in position from a means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown), or in other words in direction **99**. Alternatively, a plurality of means **56** for biasing the pivotal finger **54** could be utilized with a plurality of pivotal fingers **54**. The body **50** can be operational as previously described with a single pivotal finger **54**. However, it is preferred that the body **50** utilizes a plurality of fingers **54** and their associated plurality of means **56** for biasing the pivotal finger **54**. In addition, the plurality of fingers **54** will allow for a higher torque transmission between a selected single driven element (not shown) and the driven shaft **27**. The pivotal finger **54** also includes a drive face **98** that engages the single selected driven element cavity (not shown) and a bevel **92** to ease the axial movement of the pivotal finger **54** between selected driven element cavities (not shown) in conjunction with the means **56** for biasing the pivotal finger **54** as previously described. Note, that there is also shown a pivotal finger **54** bracket **82** that supports a pivot pin **84** for the pivotal finger **54** to pivot about, wherein the bracket **82** is attached in any conventional manner to the axially slidable body **50**, such as by welding, tongue and groove, dove tail, use of fasteners, and the like. However, the bracket **82** and the axially slidable body **50** could also be integral elements. The means **52** further has the bracket **82** being slidably engaged with a driven shaft axial slot **88** to allow for rotational engagement between the body **50** and the driven shaft axial slot **88** and thus the driven shaft **27**. The slot **88** is axially positioned and in between the driven shaft void **86** and an outside diameter **29** of the driven shaft **27**. The rotational direction **36** is shown of the driven shaft **27** with the axially slidable body **50** having the same rotational direction **36**. Means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) could be simply the use of centrifugal force from the rotation **36** of the driven shaft **27** and the means **52** as previously described. Also, the means **56** could be any number of configurations such as a leaf spring, wave spring, coil spring, rubber block, torsional rod pivot pin, and the like for accomplishing the bias of the finger **54** in direction **99**.

[0103] Continuing to **FIG. 7** shown is a perspective view of a portion of the driven shaft **27** with the axially slidable body **50** located within the driven shaft void **86**. Also shown is an axial linkage within the void **86** and that extends outward through the void **86** and outward beyond the driven shaft **27**. The axial linkage includes a direct acting control cable **94** alone that is adjacent to the axially slidable body **50** to impart selected axial movement **51** to the body **50** along the driven shaft **27** rotational axis **26** for a selected or desired axial position of the body **50** while allowing the body **50** to rotate **36** without the control cable rotating, utilizing conventional attachments such as a rotatable couple arrangement. The axial linkage can also include both the control cables, being the coupled direct acting control cable **94** and the coupled reverse acting control cable **96** with both aforementioned control cables adjacent to the axially slidable body **50** for the purpose of imparting selected bidirectional axial movement **51** to the axially slidable body **50** along the driven shaft **27** rotational axis **26** for a selected or desired axial position of the body **50**. The previously mentioned control cables preferably impart axial movement **51** to the body **50** while allowing the body to rotate **36** without the control cable rotating utilizing conventional attachments such as a rotatable couple arrangement. Thus, the direct acting control cable **94** achieves the selected axial position of the body **50** in the void **53** of the driven shaft **27** by the direct acting control cable **94** being connected to a handle bar mounted selector **60** of the bicycle **64** (not shown). If the direct acting control cable **94** is used alone then a means for urging the body **50** to a selected axial position in the void **53** in a direction opposite of what the direct acting control cable **94** would move the body **50** to along the driven shaft rotational axis **26** would be utilized in the form of a spring.

[0104] Preferably, the axial linkage would comprise both the direct acting control cable **94** and a reverse acting control cable **96** that is also adjacent to the body **50** with a rotational couple that could be used, wherein the reverse acting control cable **96** would be operable to move the body **50** in an opposite axial direction from what the direct acting control cable **94** is capable of. Thus, with the use of both the direct acting control cable **94** and the reverse acting control cable **96** to axially pull or urge the body **50** axially bidirectionally within the void **86** to the selected axial position. Both the direct acting control cable **94** and the reverse acting control cable **96** would be connected to a handle bar mounted selector **60** of the bicycle **64** (not shown). In either case, using the direct acting control cable **94** alone or the combination of the direct acting control cable **94** and the reverse acting control cable **96**, movement of the handlebar mounted selector **60** of the bicycle **64** (not shown) would result in axial movement of the body **50** within the void **86** to the selected axial position resulting in the rotational engagement of the selected single driven element (not shown) with the driven shaft **27** with the ultimate result being a selected rotational ratio between the drive shaft **25** (not shown) and the driven shaft **27**.

[0105] Also shown is a plurality rotatably unfixed transition elements **90** coaxially mounted on the driven shaft **27**, specifically on the driven shaft **27** outside diameter **29**. The plurality of transition elements **90** are axially positioned along the driven shaft **27** rotational axis **26** alternated inbetween the plurality of driven elements (removed for clarity), wherein the plurality of transition elements **90** are operational to reduce the incidence of the pivotal finger **54** engaging more than one cavity of the driven elements (removed for clarity). The transition elements **90** include internal diameter bevels **91** that are further operable to slide against the pivotal finger bevel **92** as shown in **FIG. 7** to ease the axial movement **51** of the pivotal finger **54** between the selected driven element cavities (not shown) in conjunction with the means **56** for biasing the pivotal finger **54** as previously described.

[0106] Further in **FIG. 7** shown is a perspective view of the means **52** for rotatably engaging a selected single driven element (not shown) to the driven shaft **27**. The means **52** includes the axially slidable body SO that is within a driven shaft void **86**, with axial movement denoted by **51** in relation to the driven shaft rotational axis **26** with a pivotal finger **54** or alternatively plurality of pivotal fingers **54** being biased in direction **99** about the pivot pin **84** in bracket **82** by the means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) which is in direction **99**. The pivotal finger **54** is shown in position from a means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown), or in other words in direction **99**. Alternatively, a plurality of means **56** for biasing the pivotal finger **54** could be utilized with a plurality of pivotal fingers **54**. The body **50** can be operational as previously described with a single pivotal finger **54**. However, it is preferred that the body **50** utilizes a plurality of fingers **54** and their associated plurality of means **56** for biasing the pivotal finger **54**. In addition, the plurality of fingers **54** will allow for a higher torque transmission between a selected single driven element (not shown) and the driven shaft **27**. The pivotal finger **54** also includes a drive face **98** that engages the single selected driven element cavity (not shown) and a bevel **92** to ease the axial movement of the pivotal finger **54** between selected driven element cavities (not shown) in conjunction with the means **56** for biasing the pivotal finger **54** as previously described utilizing the transition elements **90**. Note, that there is also shown a pivotal finger **54** bracket **82** that supports a pivot pin **84** for the pivotal finger **54** to pivot about, wherein the bracket **82** is attached in any conventional manner to the axially slidable body **50**, such as by welding, tongue and groove, dove tail, use of fasteners, and the like. However, the bracket **82** and the axially slidable body **50** could also be integral elements. The means **52** further has the bracket **82** being slidably engaged with a driven shaft axial slot **88** to allow for rotational engagement between the body **50** and the driven shaft axial slot **88** and thus the driven shaft **27**. The slot **88** is axially positioned and in between the driven shaft void **86** and an outside diameter **29** of the driven shaft **27**. The rotational direction **36** is shown of the driven shaft **27** with the axially slidable body **50** having the same rotational direction **36**. Means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) could be simply the use of centrifugal force from the rotation **36** of the driven shaft **27** and the means **52** as previously described. Also, the means **56** could be any number of configurations such as a leaf spring, wave spring, coil spring, rubber block, torsional rod pivot pin, and the like for accomplishing the bias of the finger **54** in direction **99**.

[0107] Further yet, to **FIG. 8** shown is a perspective view of a portion of the driven shaft **27** with the axially slidable body **50** located within the driven shaft **27** void **86** and the plurality of different diameter driven elements **40**. Note that for view clarity in **FIG. 8** the plurality of different diameter driven elements **40** that are coaxially mounted on the driven shaft **27** in a generally conical envelope are reversed in axial order from smaller to larger than is depicted in **FIGS. 2, 3,** and **4**. Returning to **FIG. 8** note that also for view clarity the plurality rotatably unfixed transition elements **90** as previously described are not shown.

[0108] Next shown is a perspective view of the structural assembly or means **52** for rotatably engaging a selected single driven element (not shown) of the plurality of different diameter driven elements **40** to the driven shaft **27**. The means **52** includes the axially slidable body **50** that is within a driven shaft void **86**, with axial movement denoted by **51** in relation to the driven shaft rotational axis **26** with a pivotal finger **54** or alternatively a plurality of pivotal fingers **54** being biased in direction **99** about the pivot pin **84** in bracket **82** by the means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) which is in direction **99**. The pivotal finger **54** is shown in position from a means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown), or in other words in direction **99**. Alternatively, a plurality of means **56** for biasing the pivotal finger **54** could be utilized with a plurality of pivotal fingers **54**. The body **50** can be operational as previously described with a single pivotal finger **54**. However, it is preferred that the body **50** utilizes a plurality of fingers S4 and their associated plurality of means **56** for biasing the pivotal finger **54**. In addition, the plurality of fingers **54** will allow for a higher torque transmission between a selected single driven element (not shown) and the driven shaft **27**. The pivotal finger **54** also includes a drive face **98** that engages the single selected driven element cavity (not shown) and a bevel **92** to ease the axial movement of the pivotal finger **54** between selected driven element cavities (not shown) in conjunction with the means **56** for biasing the pivotal finger **54** as previously described and the transition elements (not shown). Note, that there is also shown a pivotal finger **54** bracket **82** that supports a pivot pin **84** for the pivotal finger **54** to pivot about, wherein the bracket **82** is attached in any conventional manner to the axially slidable body **50**, such as by welding, tongue and groove, dove tail, use of fasteners, and the like. However, the bracket **82** and the axially slidable body **50** could also be integral elements. The means **52** further has the bracket **82** being slidably engaged with the driven shaft axial slot **88** to allow for rotational engagement between the body **50** and the driven shaft axial slot **88** and thus the driven shaft **27**. The slot **88** is axially positioned and in between the driven shaft void **86** and an outside diameter **29** of the driven shaft **27**. The rotational direction **36** is shown of the driven shaft **27** with the axially slidable body **50** having the same rotational direction **36**. Means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity (not shown) could be simply the use of centrifugal force from the rotation **36** of the driven shaft **27** and the means **52** as previously described. Also, the means **56** could be any number of configurations such as a leaf spring, wave spring, coil spring, rubber block, torsional rod pivot pin, and the like for accomplishing the bias of the finger **54** in direction **99**.

[0109] The driven shaft **27** mounts a plurality of rotatably unfixed different diameter driven elements **40** coaxially on the driven shaft **27** outside diameter **29**, specifically at an internal diameter **61** of the plurality of different diameter driven elements **40**. The plurality of different diameter driven elements **40** have a generally conical envelope (that is reversed in **FIG. 8** for view clarity as previously described) extending between the first end cover plate (not shown) and the second end cover plate (not shown), with the driven shaft **27** rotationally coupled to a bicycle rear wheel (not shown). The plurality of different diameter driven elements **40** have a plurality of driven element cavities **57** located on an internal diameter **61** of the plurality of

different diameter driven elements **40** such that at least one of the cavities **57** align (not shown) with the means **52** for rotatably engaging when there is relative rotational movement between the driven shaft **27** and the plurality of different diameter driven elements **40**. The pivotal finger **54** that is biased by means **56** to be received into a cavity (not shown) of the selected single driven element (not shown) for engaging the selected single driven element (not shown) to the driven shaft **27** when the finger **54** and the cavity (not shown) are engaged.

[0110] Looking to **FIG. 9** shown a perspective view of a portion of the driven shaft **27** with the axially slidable body **50** located within the driven shaft void **86**, with the axially slidable body **50** rotationally engaged to the selected single driven element **41**, thus rotationally affixing or engaging the selected single driven element **41** and the driven shaft **27**, in addition to the transition elements **90**. Also shown is the plurality rotatably unfixed transition elements **90** coaxially mounted on the driven shaft **27**, specifically on the driven shaft **27** outside diameter **29**. The plurality of transition elements **90** are axially, along the driven shaft **27** rotational axis **26** alternated inbetween the plurality of driven elements (removed for clarity), wherein the plurality of transition elements **90** are operational to reduce the incidence of the pivotal finger **54** engaging more than one cavity of the driven elements (removed for clarity). The transition elements **90** include internal diameter bevels **91** that are further operable to slide against the pivotal finger bevel **92** (as best shown in **FIG. 7**), to ease the axial movement **51** of the pivotal finger **54** between a selected driven element cavity **59** and an adjoining selected driven element cavity **59** (not shown) in conjunction with the means **56** for biasing the pivotal finger **54** as previously described and to reduce the incidence of the pivotal finger **54** engaging more than one driven element cavity **59** with the transition elements **90**.

[0111] Next shown is a perspective view of the structural assembly or means **52** for rotatably engaging a selected single driven element **41** of the plurality of different diameter driven elements (not shown) to the driven shaft **27**. The means **52** includes the axially slidable body **50** that is within a driven shaft void **86**, with axial movement denoted by **51** in relation to the driven shaft rotational axis **26** with a pivotal finger **54** or alternatively a plurality of pivotal fingers **54** being biased in direction **99** about the pivot pin **84** in bracket **82** by the means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity **59** which is in direction **99**. The pivotal finger **54** is shown in position from the means **56** for biasing the pivotal finger **54** toward and engaged with the single selected driven element cavity **59**, with the pivotal finger biased in direction **99**. Alternatively, a plurality of means **56** for biasing the pivotal finger **54** could be utilized with a plurality of pivotal fingers **54**. The body **50** can be operational as previously described with a single pivotal finger **54**. However, it is preferred that the body **50** utilizes a plurality of fingers **54** and their associated plurality of means **56** for biasing the pivotal finger **54**. In addition, the plurality of fingers **54** will allow for a higher torque transmission between a selected single driven element **41** and the driven shaft **27**. The pivotal finger **54** also includes a drive face **98** that is shown engaged the single selected driven element cavity **59** and a bevel **92** to ease the axial movement of the pivotal finger **54** between selected driven element cavities **59** in conjunction with the means **56** for biasing the pivotal finger **54** and transition elements **90** as previously described. Note, that there is also shown a pivotal finger **54** bracket **82** that supports a pivot pin **84** for the pivotal finger **54** to pivot about, wherein the bracket **82** is attached in any conventional manner to the axially slidable body **50**, such as by welding, tongue and groove, dove tail, use of fasteners, and the like. However, the bracket **82** and the axially slidable body **50** could also be integral elements. The means **52** further has the bracket **82** being slidably engaged with a driven shaft axial slot **88** to allow for rotational engagement between the body **50** and the driven shaft axial slot **88** and thus the driven shaft **27**. The slot **88** is axially positioned and in between the driven shaft void **86** and the outside diameter **29** of the driven shaft **27**. The rotational direction **36** is shown of the driven shaft **27** with the axially slidable body **50** having the same rotational direction **36**. Means **56** for biasing the pivotal finger **54** toward the single selected driven element cavity **59** could be simply the use of centrifugal force from the rotation **36** of the driven shaft **27** and the means **52** as previously described. Also, the means **56** could be any number of configurations such as a leaf spring, wave spring, coil spring, rubber block, torsional rod pivot pin, and the like for accomplishing the bias of the finger **54** in direction **99**.

[0112] The driven shaft **27** also mounts a plurality of rotatably unfixed different diameter driven elements (not shown) coaxially on the driven shaft **27** outside diameter **29**, specifically at an internal diameter of the plurality of different diameter driven elements (not shown). The selected single driven element **41** as being a portion of the plurality of driven elements (not shown) mounts in a like manner to the driven shaft **27** on the driven shaft **27** outside diameter **29**, specifically at an internal diameter **55** of the selected single driven element **41**. The plurality of different diameter driven elements (not shown) have a generally conical envelope (that is reversed in **FIG. 8** for view clarity as previously described) extending between the first end cover plate (not shown) and the second end cover plate (not shown), with the driven shaft **27** rotationally coupled to a bicycle rear wheel (not shown). The plurality of different diameter driven elements (not shown) have a plurality of driven element cavities (not shown) located on an internal diameter (not shown) of the plurality of different diameter driven elements (not shown) such that at least one of the cavities align (not shown) with the means **52** for rotatably engaging when there is relative rotational movement between the driven shaft **27** and the plurality of different diameter driven elements (not shown). The pivotal finger **54** that is biased by means **56** to be received into the cavity **59** of the selected single driven element **41** for engaging the selected single driven element **41** to the driven shaft **27** when the finger **54**, or more specifically the drive face **98** that is shown engaged with the single selected driven element cavity **59**. When the selected single driven element **41** is rotationally engaged to the driven shaft **27**, the remaining plurality of different diameter driven elements (not shown) are rotationally unfixed to the driven shaft **27**, thus at any one time only a single one selected single driven element **41** is rotationally engaged to the driven shaft **27**. When the body **50** is at the selected axial position, the body **50** will act to rotationally engage the selected single driven element **41** to establish the selected rotational ratio between the drive shaft **25** (not shown) and the driven shaft **27**.

[0113] Further to **FIG. 10** shown is a flat layout view of the handlebar mounted selector **60** for the bicycle rider

selected drive train transmission ratios in conjunction with the cable tensioning assemblies **100** and the axially slidable body **50**. The cable tensioner assembly **100** is mounted inline and inbetween a direct acting control cable **46** and a coupled direct acting control cable **94**, also a cable tensioner **100** is mounted inline and inbetween a reverse acting control cable **48** and a coupled reverse acting control cable **96**. The cable tensioner assembly is positioned inbetween the handlebar mounted selector **60** and the body **50**. Wherein the cable tensioner assembly **100** is operational to limit the axial force on the aforementioned coupled direct acting control cable **94** and coupled reverse acting control cable **96** transmitted between the handlebar mounted selector **60** and the body **50**.

[0114] Next to **FIG. 11** shown is an expanded view of the cable tensioning assembly **100** that includes a cable tensioner housing **102**, that has the direct acting control cable **46** and the reverse acting control cable **48** that each have a cable slip fit **104** in each respective cable tensioner housing **102**, with the direct acting control cable **46** and the reverse acting control cable **48** each being attached to a respective retainer **108** that is slidably engaged with the housing **102**. Further, a means **110** for controlling cable axial tension that can be a spring or the like is between the housing **102** and the retainer **108**. Coupled direct acting control cable **94** and coupled reverse acting control cable **96** are each attached **106** to the each respective housing **102**.

[0115] Next, looking to **FIG. 12** shown is a perspective view of a handlebar assembly **58** mounted selector **60** that is attached to the direct acting control cable **46** and the reverse acting control cable **48**. The bicycle rider rotationally moves the selector **60** through the rotational motion as denoted by a handle rotation **62** to push and pull the aforementioned cables that are rotationally coupled to the body **50** (not shown) to selectively achieve the desired rotational ratio between the drive shaft **25** (not shown) and the driven shaft **27** (not shown). Alternatively, if the direct acting control cable **46** is used alone in the selector **60** would only act to pull the direct acting control cable **46** with the cable being able to retract in the opposite direction through the means for urging the body **50** (not shown) as previously described.

[0116] Finally, **FIG. 13** shown is a side elevation of a bicycle **64** including a bicycle frame **66**, a front wheel **68**, a rear wheel **70**, a seat **72**, and the handlebar assembly **58**. The bicycle **64** incorporates the present invention of the bicycle drive train assembly **20** that is mounted at a lower middle junction **74** of the bicycle frame **66**. A bicycle pedal assembly **76** including bicycle pedals **78** is affixed to the drive shaft **25** wherein the pedal assembly **76** is journalled therein with respect to the housing assembly **22**. The driven shaft **27** of the bicycle drive train assembly **20** has the drive toothed wheel **44** that is rotationally attached to the driven shaft **27**. The drive toothed wheel **44** is rotationally coupled to the bicycle rear wheel **70** through the use of a final drive belt **80** and driven toothed wheel **45**. The driven toothed wheel **45** is attached to the bicycle rear wheel **70** through a conventional one way clutch also known as a free wheel to allow free backpedaling as in a conventional bicycle. However, the one way clutch is not absolutely needed as the required free wheeling can be accomplished at the pivotal finger and driven element internal diameter interface by use of a conventional one way ratchet design for the driven element cavities as shown in **FIG. 9**. Alternatively, the final drive belt **80** could be a conventional bicycle chain with the drive toothed wheel **44** becoming a drive chain sprocket and the driven toothed wheel **45** becoming a driven chain sprocket. In addition, further extension of the overall rotational ratio between the bicycle pedals assembly **76** and the bicycle rear wheel **70** can be accomplished by changing the diameters of the drive toothed wheel **44** and the driven toothed wheel **45** to accommodate a different bicycle rider, bicycle, or terrain. This, for example, would be to transfer or convert the bicycle from a mountain bike to a road bike and vice versa.

Conclusion

[0117] Accordingly, the present invention of a bicycle drive train has been described with some degree of particularity directed to the embodiments of the present invention. It should be appreciated, though, that the present invention is defined by the following claims construed in light of the prior art so modifications the changes may be made to the exemplary embodiments of the present invention without departing from the inventive concepts contained therein.

1. A drive train for a bicycle, comprising:

(a) a housing assembly mounted at a lower middle junction of a bicycle frame, which has a pedal assembly journalled therein;

(b) a drive shaft fixably mounting a plurality of different diameter drive elements coaxially, said drive shaft having a drive shaft rotational axis and being journalled in and between a housing first end cover plate and a housing second end cover plate of said housing assembly, the pedal assembly rotationally coupled to said drive shaft, said drive elements having a generally conical envelope extending between said first end cover plate and said second end cover plate;

(c) a driven shaft journalled in and between said first end cover plate and said second end cover plate, said driven shaft having a driven shaft rotational axis positioned parallel to said drive shaft rotational axis, said driven shaft mounting a plurality of rotatably unfixed different diameter driven elements coaxially, said driven elements having a generally conical envelope extending between said first end cover plate and said second end cover plate, said driven shaft rotationally coupled to a bicycle rear wheel;

(d) a plurality of connection elements for rotationally coupling said plurality of different diameter drive elements to said plurality of different diameter driven elements such that a single connection element rotatably couples a single drive element to a single driven element that are in alignment; and

(e) a means for rotatably engaging a selected single driven element to said driven shaft to establish a selected rotational ratio between said drive shaft and said driven shaft.

2. A drive train for a bicycle according to claim 1 wherein said means for rotatably engaging is an axially slidable body in a void within said driven shaft movable to a selected axial position along said driven shaft rotational axis corresponding to engaging said selected single driven element, said selected axial position is accomplished by an axial linkage within said void that is adjacent to said body and extends beyond said driven shaft.

3. A drive train for a bicycle according to claim 2 wherein said driven shaft has an axial slot between said void and an outside diameter of said driven shaft, wherein said slot rotationally engages said body.

4. A drive train for a bicycle according to claim 3 wherein said plurality of different diameter driven elements have a plurality of cavities located on an internal diameter of said plurality of different diameter driven elements such that at least one of said cavities align with said means for rotatably engaging when there is relative rotational movement between said driven shaft and said plurality of different diameter driven elements.

5. A drive train for a bicycle according to claim 4 wherein said body further comprises a pivotal finger that is biased to be received into a cavity of said selected single driven element for engaging said selected single driven element to said driven shaft when said finger and said cavity are engaged.

6. A drive train for a bicycle according to claim 5 wherein said finger is biased by a spring.

7. A drive train for a bicycle according to claim 5 further comprising a plurality rotatably unfixed transition elements coaxially mounted on said driven shaft, said plurality of transition elements are axially alternated inbetween said plurality of driven elements, wherein said plurality of transition elements are operational to reduce the incidence of said finger engaging more than one said cavity.

8. A drive train for a bicycle according to claim 5 wherein said body further comprises a plurality of fingers.

9. A drive train for a bicycle according to claim 8 wherein said plurality of fingers are biased by a plurality of springs.

10. A drive train for a bicycle according to claim 2 wherein said axial linkage is a direct acting control cable attached to a handlebar mounted selector on the bicycle wherein movement of said handlebar selector moves said direct acting control cable resulting in selected axial movement of said body within said void.

11. A drive train for a bicycle according to claim 10 wherein said axial linkage further comprises a reverse acting control cable that is operable to move in an opposite direction from said direct acting control cable to axially pull said body axially selectively bidirectionally within said void.

12. A drive train for a bicycle according to claim 10 further comprising a cable tensioner assembly mounted inline to said cable and positioned inbetween said handlebar mounted selector and said body, wherein said cable tensioner assembly is operational to limit the axial force on said cable transmitted between said handlebar mounted selector and said body.

13. A drive train for a bicycle, comprising:

(a) a housing assembly mounted at a lower middle junction of a bicycle frame, which has a pedal assembly journalled therein;

(b) a drive shaft fixably mounting a plurality of different diameter drive chain sprockets coaxially, said drive shaft having a drive shaft rotational axis and being journalled in and between a housing first end cover plate and a housing second end cover plate of said housing assembly, the pedal assembly rotationally coupled to said drive shaft, said drive chain sprockets having a generally conical envelope extending between said first end cover plate and said second end cover plate;

(c) a driven shaft journalled in and between said first end cover plate and said second end cover plate, said driven shaft having a driven shaft rotational axis positioned parallel to said drive shaft rotational axis, said driven shaft mounting a plurality of rotatably unfixed different diameter driven chain sprockets coaxially, said driven chain sprockets having a generally conical envelope extending between said first end cover plate and said second end cover plate, said driven shaft rotationally coupled to a bicycle rear wheel;

(d) a plurality of chain drive loops for rotationally coupling said plurality of different diameter drive chain sprockets to said plurality of different diameter driven chain sprockets such that a single chain drive loop rotatably couples a single drive chain sprocket to a single driven chain sprocket that are in alignment; and

(e) a means for rotatably engaging a selected single driven chain sprocket to said driven shaft to establish a selected rotational ratio between said drive shaft and said driven shaft.

14. A drive train for a bicycle according to claim 13 wherein said means for rotatably engaging is an axially slidable body in a void within said driven shaft movable to a selected axial position along said driven shaft rotational axis corresponding to engaging said selected single driven chain sprocket, said selected axial position is accomplished by an axial linkage within said void that is adjacent to said body and extends beyond said driven shaft.

15. A drive train for a bicycle according to claim 14 wherein said driven shaft has an axial slot between said void and an outside diameter of said driven shaft, wherein said slot rotationally engages said body.

16. A drive train for a bicycle according to claim 15 wherein said plurality of different diameter driven chain sprockets have a plurality of cavities located on an internal diameter of said plurality of different diameter driven chain sprockets such that at least one of said cavities align with said means for rotatably engaging when there is relative rotational movement between said driven shaft and said plurality of different diameter driven chain sprockets.

17. A drive train for a bicycle according to claim 16 wherein said body further comprises a pivotal finger that is biased to be received into a cavity of said selected single driven chain sprocket for engaging said selected single driven chain sprocket to said driven shaft when said finger and said cavity are engaged.

18. A drive train for a bicycle according to claim 17 wherein said finger is biased by a spring.

19. A drive train for a bicycle according to claim 17 further comprising a plurality rotatably unfixed transition elements coaxially mounted on said driven shaft, said plurality of transition elements are axially alternated inbetween said plurality of driven chain sprockets, wherein said plurality of transition elements are operational to reduce the incidence of said finger engaging more than one said cavity.

20. A drive train for a bicycle according to claim 17 wherein said body further comprises a plurality of fingers.

21. A drive train for a bicycle according to claim 20 wherein said plurality of fingers are biased by a plurality of springs.

22. A drive train for a bicycle according to claim 14 wherein said axial linkage is a direct acting control cable attached to a handlebar mounted selector on the bicycle

wherein movement of said handlebar selector moves said direct acting control cable resulting in selected axial movement of said body within said void.

23. A drive train for a bicycle according to claim 22 wherein said axial linkage further comprises a reverse acting control cable that is operable to move in an opposite direction from said directing acting control cable to axially pull said body axially selectively bidirectionally within said void.

24. A drive train for a bicycle according to claim 22 further comprising a cable tensioner assembly mounted inline to said cable and positioned inbetween said handlebar mounted selector and said body, wherein said cable tensioner assembly is operational to limit the axial force on said cable transmitted between said handlebar mounted selector and said body.

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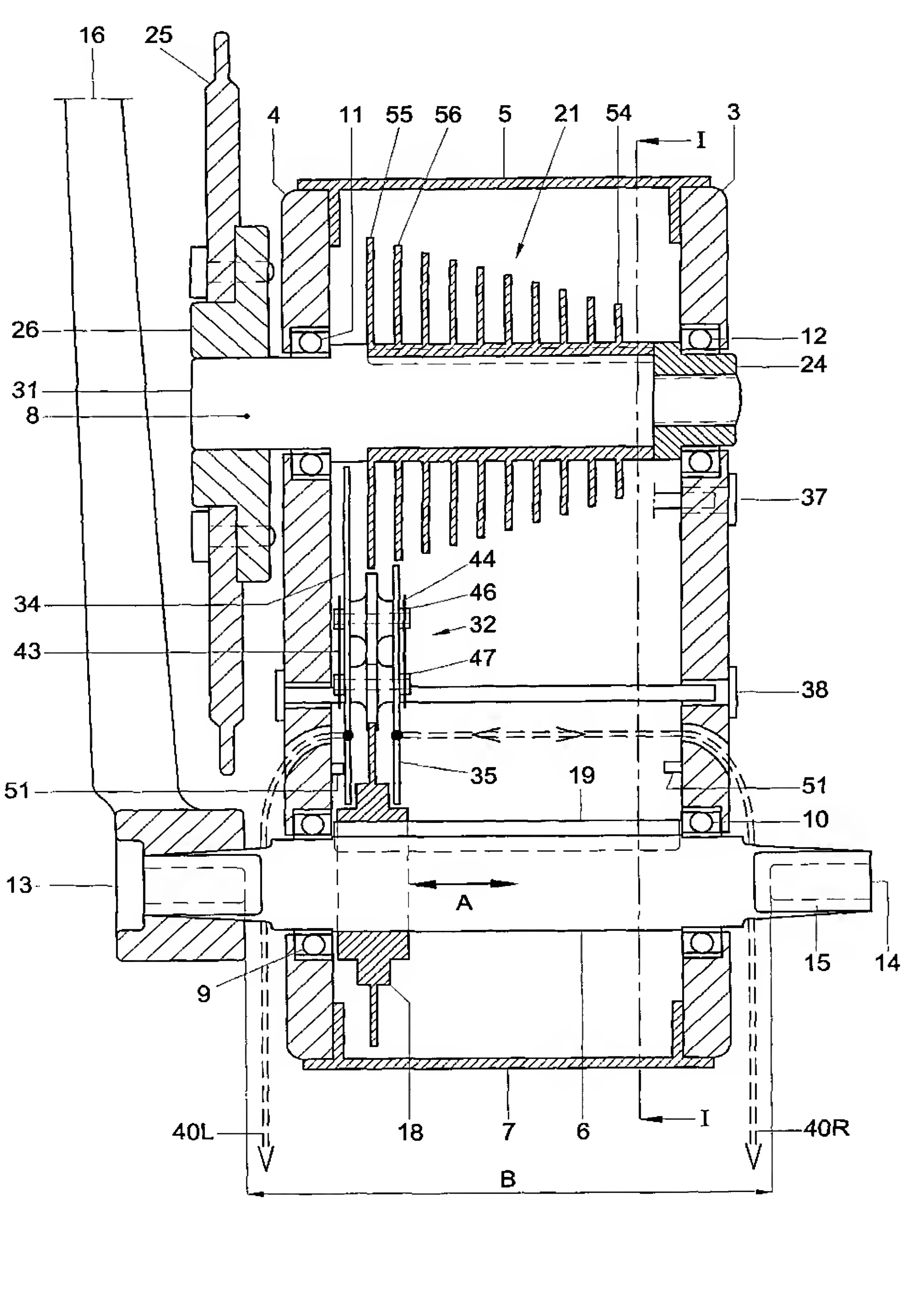
(54) Title: GEAR FOR A BICYCLE



(57) Abstract: The invention relates to a compact installation gear with, for instance, a 3/8" derailleur chain and a derailleur for setting a transmission ratio between a crankshaft and a rear hub of a bicycle. To that end, the gear comprises a compact housing with the crankshaft included therein, with a slidable driving first sprocket engaging, via the derailleur chain, a selected second sprocket which forms part of a series of second sprockets mutually different in diameter, located on a secondary shaft with a third sprocket mounted thereon outside the housing, which, in turn, via a roller chain, drives a fourth sprocket on the rear hub. The transmission ratio can be set with the aid of the derailleur by moving the derailleur chain over the different second sprockets while at the same time moving the driving first sprocket to a position directly opposite the selected second sprocket.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Title: Gear for a bicycle

The invention relates to a gear for setting a transmission ratio between a crankshaft and a rear hub of a bicycle.

From practice, a gear is known wherein a sprocket cassette, located on a rear hub and containing a number of sprockets of different diameter, is driven via a bicycle chain by a sprocket fixedly mounted on a crankshaft. To obtain a desired transmission ratio between the crankshaft and the rear hub, the bicycle chain is moved between the different sprockets on the rear hub with the aid of a derailleur, located near the rear hub. To that end, the derailleur comprises a chain tensioner with two guiding wheels, over which and between which the bicycle chain is guided. By means of two parallel arms, these guiding wheels can be positioned directly opposite each of the respective sprockets, thus moving the part of the bicycle chain between the guiding wheels and the sprockets in a parallel manner.

A drawback of the known gear is that the sprocket cassette and the derailleur take up a lot of space on and near the rear hub. As a result, the rear wheel has to be spoked in an asymmetrical manner, at the expense of the stability and strength of this rear wheel. Furthermore, it is difficult to screen the arrangement from moisture and dirt.

The invention aims to provide a gear wherein the drawbacks of the known gear are avoided, while its advantages are maintained. To that end, a gear according to the invention is characterized by the features of claim 1.

By moving the series of sprockets and the derailleur from the rear hub to a secondary shaft near the crankshaft, a very compact gear is obtained. Due to the limited dimensions, this gear can be readily provided with a protective housing. Furthermore, on the rear hub, a single fourth sprocket can suffice. Thus, space is created to spoke the rear wheel in a symmetrical manner, so that an even loading of the spokes and the wheel rim is obtained, which is of benefit to the strength and stability of the rear wheel.

In an advantageous embodiment, a gear according to the invention is characterized by the features of claim 2.

As the driving first sprocket can move in axial direction on the crankshaft, a very compact derailleur can be built, while optimal use is made of the space between cranks mounted on both sides on the crankshaft. With this derailleur, a gear can be realised which fits between the cranks and which hardly projects on either side of the frame.

In a further embodiment, a gear according to the invention is characterized by the features of claim 3.

With a derailleur according to the invention, the driving first sprocket can in each case be positioned directly opposite the second sprocket to be driven. The first roller chain therefore lies in line between these sprockets, so that this roller chain is only loaded in longitudinal direction, which is favorable to its life span. Moreover, as no kinks or curves have to be compensated in the roller chain, a very short chain suffices, so that the distance between the crankshaft and the secondary shaft can be reduced. In this manner, an even more compact gear is obtained.

In a further advantageous embodiment, a gear according to the invention is characterized by the features of claims 5 and 6.

The freedom of choice in diameter of the driving first and third sprockets and the driven second and fourth sprockets, offers the possibility to optimize aspects of the gear while maintaining a desired transmission ratio between the crankshaft and the rear hub. An aspect to be optimised can be, for instance, the dimensions of the gear. For a more compact gear, the diameter of the driving third sprocket on the secondary shaft can be selected to be relatively small, so that the distance between the secondary shaft and the crankshaft can be reduced. To compensate this smaller driving third sprocket, the diameter of the driving first sprocket can be increased and/or the diameters of the fourth sprocket on the rear hub and/or the second sprockets

on the secondary shaft can be reduced in order to still maintain a sufficiently large transmission ratio between the crankshaft and the rear hub.

In a comparable manner, other aspects can be optimised such as the operation of the derailleur, which can be improved by selecting the difference in diameter between successive second sprockets to be small, or the forces on the secondary shaft, which can be reduced by reducing the second and third sprockets mounted thereon.

In a further embodiment, a gear according to the invention is characterized by the features of claim 7.

The transmission range of the gear and the step size between the successive transmission ratios is determined by the amount of gearing of the second sprockets as well as by the difference in the number of teeth between the successive second sprockets. Thus, either a large transmission range with relatively large steps between the successive transmission ratios or a smaller transmission range with a finer adjustment possibility can be realised. Hence, with the choice of the second sprockets, the gear can be adjusted to the demands of various types of bicycles and riding situations.

In an advantageous embodiment, a gear according to the invention is characterized by the features of claim 10.

With a narrow roller chain, the second sprockets on the secondary shaft can be positioned closer together so that a still narrower gear can be obtained. However, it is also possible to install more second sprockets while the width of the gear remains the same, so that the number of speed options of the gear increases.

In an especially advantageous embodiment, a gear according to the invention is characterized by the features of claim 12.

Due to the compact construction, the gear can simply be enclosed in a housing. This protects the gear from external influences, such as moisture and dirt. It leads to less wear of the parts, less maintenance and a longer life span. Additionally, the housing offers the cyclist protection, for instance with

respect to splashing dirt and the risk of clothing getting caught between the moving parts. Further, the housing contributes constructively to the support of the driving parts, i.e. the crankshaft and the secondary shaft. These shafts can be bearing mounted in the housing in a simple manner. Finally, the housing facilitates the installation and attachment of the gear to the bicycle, the more so when the housing is fixedly mounted in the frame of the bicycle with a mounting bracket.

The invention also relates to a bicycle provided with a gear according to the invention, characterized by the features of claim 19.

Due to the limited dimensions of the gear and the rigidity of the housing, the gear can be mounted in the bicycle frame in several positions, with the position of the crankshaft being substantially fixed while the position of the secondary shaft in relation to the crankshaft can be varied. As a result, the gear is suitable for installation in frames of various shapes and sizes.

In the additional subclaims, further advantageous embodiments of a gear according to the invention and a bicycle provided with such a gear are described.

In clarification of the invention, an exemplary embodiment of a gear according to the invention as well as its operation and a method for installation of such a gear in a bicycle will be further elucidated on the basis of the drawing.

In the drawing:

Fig. 1 shows, in side view, a cross section of a gear according to the invention at the line I-I in Fig. 2;

Fig. 2 shows, in top plan view, a cross section of the gear of Fig. 1 at the line II-II in Fig. 1;

Fig. 3 shows, in side view, two positions of a chain tensioner of a derailleur according to Figs. 1 and 2;

Fig. 4 shows a step of the installation process of a gear according to the invention; and

Fig. 5 shows two bicycles with possible installation positions of a gear according to the invention.

Figs. 1 and 2 show, in cross section, a side and top plan view, respectively, of a gear 1 which can be installed near a crankshaft 6 of a bicycle 30 between frame parts of that bicycle. With the gear 1, the transmission ratio between the crankshaft 6 driven by a cyclist and a rear hub 29, and hence the acceleration, can be adjusted to, inter alia, the riding conditions and the personal preference of the cyclist. What is meant hereinbelow by transmission ratio is the relation between the number of revolutions of a driving shaft and the number of revolutions of a driven shaft. What is meant by acceleration is the product of the transmission ratio between crankshaft and rear hub and the wheel diameter of the bicycle.

The gear 1 is included in a housing 2, comprising a first side plate 3 and a second side plate 4, which are mutually connected along their circumference by a mounting bracket 5. With this mounting bracket 5, the gear 1 can be mounted onto the bicycle, in a manner to be described hereinafter. Between the first side plate 3 and the second side plate 4, a crankshaft 6 is bearing-mounted by means of a first and a second ball bearing 9, 10. Parallel to the crankshaft 6, and at a relative short distance therefrom, a secondary shaft 8 is bearing-mounted in a third and a fourth ball bearing 11, 12, respectively. The secondary shaft 8 is driven by the crankshaft 6 by means of a first sprocket 18 on the crankshaft 6 which, via a first roller chain 20, is connected to a second sprocket 22 which forms part of a sprocket cassette 21 on the secondary shaft 8. The secondary shaft 8, in turn, drives a rear hub 29 by means of a third sprocket 25 which, via a second roller chain 27, engages a fourth sprocket on the rear hub 29.

To drive the crankshaft 6, two ends 13, 14 of this crankshaft 6, reaching outside the housing 2, are connected in a manner known per se via cranks 16 to pedals (not shown). The connection between the cranks 16 and the crankshaft ends 13, 14 is such that it can transmit the substantial forces

applied by a cyclist to the pedals to the crankshaft 6. This can be done in a manner known per se, for instance by means of a key connection, or, as shown in Figs. 1 and 2, by means of a keyless, form-closed connection, whereby the forces mentioned are transmitted via four levelled sides 15 of the tapered crankshaft ends 13, 14.

The driving first sprocket 18 is mounted on the crankshaft 6 with the aid of a key 19. To that end, the crankshaft 6 is provided with a keyway, while the first sprocket 18 is provided with a shaft hole such that it can move, guided by the key, in the axial direction of the crankshaft 6, as indicated by the arrow A in Fig. 2, but cannot rotate relative to this crankshaft 6. It will be directly clear that such a connection can also be brought about in another manner known from practice, for instance by means of a cam in the shaft hole of the first sprocket 18, which engages in an axially extending slot in the surface of the crankshaft 6, or by means of a key toothing, extending over the length of the crankshaft 6, and a cooperating shape of the shaft hole in the first sprocket 18.

The driving third sprocket 25 is fixedly mounted on an end 31 of the secondary shaft 8, for instance by means of a pulley 26, which end 31 extends through the second side plate 4 to outside the housing 2. Further, on this secondary shaft 8, a sprocket cassette 21 is mounted so as to be secured against rotation, by means of, for instance, a second key 23 and a clamping nut 24, as shown in Fig. 2. The sprocket cassette 21 comprises a series of second sprockets 22, with different diameters and different numbers of teeth. The second sprockets 22 are arranged from large to small, the largest second sprocket 55 being preferably located near the driving third sprocket 25 to decrease the torsional forces on the secondary shaft 8.

The first roller chain 20, between the driving first sprocket 18 and a respective one of the second sprockets 22, has links of a length of, preferably, maximally 3/8" (9.5 mm). The space available widthwise for the gear 1 is determined by the distance B between the cranks 16, which distance varies per

type of bicycle. By using a relatively narrow roller chain 20, more second sprockets 22 can be positioned within the limited width B, so that the number of possible transmission ratios increases.

For moving the roller chain 20 between the second sprockets 22, the gear 1 is provided with a derailleur 32. This derailleur 32 comprises a first, and, parallel thereto, a second plate 34, 35. These plates 34, 35 are movable along two guiding pins 37, 38, which are mounted parallel to the crankshaft 6 between the first and second side plates 3, 4 of the housing 2. The plates 34, 35 extend between the sprocket cassette 21 on the secondary shaft 8 and the crankshaft 6, while overlapping, at least partially, the driving first sprocket 18 on both sides. The mutual distance between the plates 34, 35 is such that, when moving the plates 34, 35 along the guiding pins 37, 38, the driving first sprocket 18 is moved along therebetween and therefore moves along the crankshaft 6, while, with the plates 34, 35 at a standstill, the driving first sprocket 18 can preferably rotate freely between the plates 34, 35. The plates 34, 35 of the derailleur 32 are connected, at the sides remote from each other, to a first end of an operating cable 40, which operating cables are connected at a second end to an operating handle 41 on or near the handlebar 59 of the bicycle 30. With the aid of this operating handle 41 and the cables 40, the plates 34, 35 and the first sprocket 18 located therebetween can be moved along the guiding pins 37, 38, respectively, and the crankshaft 6.

The derailleur is further provided with a chain tensioner 42, for accompanying the lateral movement of the roller chain 20 along the different second sprockets 22 and for compensating the occurring differences in necessary chain length. To that end, the chain tensioner 42 comprises two parallel arms 43, 44 which can swivel about a swivel pin 45, extending perpendicularly to the plates 34, 35. Between the ends of the swivelling arms 43, 44, a first and a second guiding wheel 46, 47 are rotatably suspended between the plates 34, 35. At some distance from the swivel pin 45, a draw spring 48 engages the two swivelling arms 43, 44, under the influence of which

the chain 20, which is guided between the two guiding wheels 46, 47, is tensioned. In Figs. 3a and 3b are shown two extreme positions of the chain tensioner 42, which occur when the roller chain 20 engages a second sprocket having a larger diameter 55 or a smaller diameter 54, respectively. In the first position (Fig. 3a), for instance, the full length of the roller chain 20 is needed to embrace the driving first sprocket 18 and the second sprocket 55. The chain tensioner 42 is in an extreme position, in which the draw springs 48 are stretched out and the roller chain 20 lies approximately stretched out between the guiding wheels 46, 47. In the second position (Fig. 3b), a shorter chain length suffices to embrace the driving first sprocket 18 and the second sprocket 54. Under the influence of the draw springs 48, the first guiding wheel 46 exerts an upward force and the second guiding wheel 47 a downward force on the roller chain 20, so that the excess length of the chain 20 is tensioned in an S-bend between the two guiding wheels 46, 47. Thus, the chain 20 remains under sufficient tension during its movement along and its cooperation with the different sprockets 22, 54, 55. The concept of chain tensioner 42 should, for that matter, be herein understood to mean a guiding element suitable for guiding and tensioning all types of chains that can be used between the driving first and one of the second sprockets 18, 22.

Due to the limited space between the plates 34, 35, the swivelling arms 43, 44 and the draw springs 48 are mounted on the outside of the plates 34, 35 in the example shown in Figs. 1 and 2. Further, for the purpose of the path travelled by the guiding wheels 46, 47 during the guidance of the roller chain 20 between the two extreme sprocket positions, the plates 34, 35 are provided with two arcuate slots 49, 50.

Further, the derailleur 32 is preferably provided with limiting means 51, with which the stroke of the driving first sprocket 18 along the crankshaft 6 is limited. In this manner, the driving first sprocket 18 is prevented from being moved beyond the outermost two sprockets 54, 55. Such a limitation can, for instance, be formed by a projection or a different spacer

between, on the one hand, the first side plate 3 and/or the second side plate 4 and, on the other hand, the plates 34, 35.

The operation of the gear 1 as described hereinabove is as follows. The starting position is, for instance, the position shown in Fig. 2, where the driving first sprocket 18 lies opposite the largest second sprocket 55, which corresponds to the smallest transmission ratio, that is, the lowest speed of the gear. In this position, the operating handle 41 will also be in an extreme position, so that the left operating cable 40_L, shown in Fig. 2, cannot be pulled further to the left. Optionally, to this end, a limiting means 51 as already described above can be provided. If the operating handle 41 is moved in the opposite direction, corresponding to the pulling of the right-hand operating cable 40_R, the two plates 34, 35 will move to the right along the guiding pins 37, 38, thereby also moving the driving first sprocket 18 along the crankshaft 6. Also the roller chain 20 is thereby pulled sideward so that, at a certain moment, a tooth of the largest sprocket but one 56 will engage a link of the roller chain 20, after which the other teeth and links follow. The chain length necessary for embracing the sprocket 56 is somewhat shorter than the length necessary for the sprocket 55. The difference in length is compensated in the manner described hereinabove by the chain tensioner 42. In this manner, the driving first sprocket 18 will be moved along the successive second sprockets 22 to the smallest second sprocket 54. Preferably, a limiting means 51 is built in at that side for preventing further movement of the driving first sprocket 18. By operating the handle 41 in the opposite direction, the driving first sprocket 18 will move back in the direction of the largest sprocket 55 in the same manner as described hereinabove, except that in this case the necessary length of the roller chain will increase. The chain tensioner 42 will therefore, during the movement of the sprocket 18 along the crankshaft 6, be moved from a position shown in Fig. 3b to a position shown in Fig. 3a.

Fig. 4 shows an example of how the gear 1 can be installed in a bicycle 30. The mounting bracket 5 is fixed to several bars of the bicycle frame,

for instance by welding. This mounting bracket 5 is of a strong and rigid design which is such that it can absorb and transmit propelling forces to the rest of the bicycle frame. For instance, the bracket can be manufactured from steel, but, with a view to the reduction of weight, is preferably manufactured from aluminum, or plastic, or the like. After fitting the bracket 5, the first and second side plate 3, 4, having therebetween the crankshaft 6, the secondary shaft 8, the sprocket cassette 21 and the derailleur 32, can be slid as a whole into the mounting bracket 5. The bracket 5 and the housing plates 3, 4 are provided, at mutually corresponding positions, with holes 60 with which the above parts can be mounted onto each other by means of bolts and nuts. Then, a cover 7 can be provided at the location of the interruption in the mounting bracket 5 through which the gear has been slid in, so that, in mounted condition, a closed housing 2 is formed by the first side plate 3, the second side plate 4, the mounting bracket 5 and the cover 7. Naturally, the housing 2 with the bracket 5 can also be mounted in a bicycle in one go. Due to the housing 2, the gear 1 can be installed in a very simple manner. Additionally, the gear 1 is protected by the housing 2 from dirt, moisture and unforeseen external forces and the cyclist is protected, during use, from undesired contact with moving parts of the gear 1. Furthermore, the housing 2, especially the bracket 5, gives the construction the necessary rigidity and strength as has been indicated hereinabove. This autonomous rigidity and the limited dimensions of the gear 1 give the gear a lot of freedom of installation. Although the position of the crankshaft 6 is substantially fixed, the position of the secondary shaft 8 can be varied. Two examples hereof are represented in Figs. 5a and b. In Fig. 5a, viewed in the riding direction, the secondary shaft 8 is located behind the crankshaft 6, at approximately the same height as the crankshaft 6, while in Fig. 5b the secondary shaft 8 is located obliquely above the crankshaft 6, in line with a saddle tube. These different installation positions affect, inter alia, the orientation and length of the rear fork. Assuming that the rear fork is preferably mounted approximately parallel to the upper half of the second

roller chain for obtaining the most favorable pressure load instead of bending load, a shortest possible rear fork can be realised in an installed position as shown in Fig. 5b, which may be desirable, for instance, for racing bikes. Due to the different installation possibilities, the gear 1 is therefore suitable for use in a large number of frames varying in shape and size.

Further, with a gear 1 according to the invention, the rear wheel of the bicycle can be symmetrically spoked, since the rear hub 29 only needs to be equipped with a single fourth sprocket 28, and moreover this sprocket 28 can be of limited dimension when the driving third sprocket 25 is suitably selected. This is in contrast to the known gears, wherein the second sprockets are located on the rear hub and take up such an amount of space there that the left- and right-hand side of the rear wheel have to be provided with different spokes, which, moreover, have to be disposed in different positions. A symmetrically spoked wheel is stronger, more stable and has a longer life span since the forces acting on the wheel are evenly distributed over the spokes. Moreover, a symmetrical spoking is easier to provide.

It will be clear that the invention is not limited to the exemplary embodiments given in the description and the drawing. Many variations are possible within the scope of the invention as outlined by the claims.

For instance, the gear can be combined with an overdrive outside of the housing. To that end, an extra driving sprocket can be placed next to the driving third sprocket on the secondary shaft. Its installation can be executed with a front derailleur known from practice, while an extra chain tensioner is necessary for keeping the second roller chain between the secondary shaft and the rear hub tensioned. Thus, either the number of speed possibilities of the gear increases, or the same number of speeds can be obtained with fewer second sprockets.

Also, a gear according to the invention can be combined with a gear known from practice, whereby the rear hub is provided with a narrow sprocket cassette with only two or three sprockets at most and an associated second

derailleur. Thus, the number of transmission ratios to be set increases still further. The same result can be achieved by installation of a gear hub, for instance a 3-gear hub. Furthermore, one of the operating cables of the derailleur can be replaced with springs between a plate of the derailleur and a side plate of the housing. Thus, a simpler operating mechanism is obtained and, moreover, when an operating cable breaks or comes loose, the derailleur returns to a preferred position, for instance opposite the smallest second sprocket. Means known per se can be used for positive adjustment of the different transmission ratios.

These and many variations are considered to fall within the scope of the invention as outlined by the claims.

Claims

1. A gear for setting a transmission ratio between a crankshaft and a rear hub of a bicycle, comprising a driving first sprocket (18) mounted on the crankshaft (6), which can be coupled via a first roller chain (20) and a derailleur (32) to a sprocket as desired from a series of second sprockets (22) different in diameter which are mounted on a secondary shaft (8), which secondary shaft (8) is located parallel to and at a relatively short distance from the crankshaft (6) and to which secondary shaft (8), further, a driving third sprocket (25) is mounted, which, via a second roller chain (27), is connected to a fourth sprocket (28) on the rear hub (29).

2. A gear according to claim 1, wherein the driving first sprocket (18) is movable in axial direction along the crankshaft (6) with the aid of the derailleur (32).

3. A gear according to claim 1 or 2, wherein the driving first sprocket (18), with the aid of the derailleur (32), is positionable directly opposite each of the series of second sprockets (22) mounted on the secondary shaft (8), the arrangement being such that the first roller chain (20) is in each case in line with said first and second sprockets (18, 22) and is loaded substantially in the longitudinal direction.

4. A gear according to any one of the preceding claims, wherein the derailleur (32) comprises two parallel plates (34, 35) connected to each other at some distance from each other, which, by means of at least one operating cable (40), are movable in a direction parallel to the crankshaft (6), and which plates (34, 35) are positioned relative to the driving first sprocket (18), such that when the plates (34, 35) are at a standstill, this first sprocket (18) can rotate therebetween without contacting the plates and, during movement of the plates (34, 35), can move along between them, along the crankshaft (6).

5. A gear according to any one of the preceding claims, wherein the series of second sprockets (22) on the secondary shaft (8) is arranged from large to small, the largest sprocket (55) being preferably located on the side of the driving third sprocket (25).

6. A gear according to any one of the preceding claims, wherein the diameter of the largest second sprocket (55) on the secondary shaft (8) is smaller than or equal to the diameter of the driving first sprocket (18).

7. A gear according to any one of the preceding claims, wherein the second sprockets (22) on the secondary shaft (8) comprise between 11 and 24 teeth.

8. A gear according to any one of the preceding claims, wherein the first roller chain (20) is a derailleur chain and has a link length which is smaller than 12.7 mm (1/2"), preferably smaller than 9.5 mm (3/8") and, in particular, approximately 8 mm.

9. A gear according to any one of the preceding claims, wherein the first roller chain (20) has an internal link width which is smaller than 3.2 mm (1/8") and preferably 2.6 mm and wherein the external link width is equal to approximately 7 mm.

10. A gear according to any one of the preceding claims, wherein the derailleur (32) between the plates (34, 35) comprises a chain tensioner (42) for guiding and tensioning the first roller chain (20).

11. A gear according to claim 10, wherein the chain tensioner (42) comprises an arm (44) swivelling parallel to the plates (34, 35), which arm is provided at both ends with guiding wheels (46, 47), which, by means of a bias spring (48) connected to the arm (44), can be pushed against the roller chain (20) on opposite sides, so that the roller chain (20) is tensioned.

12. A gear according to any one of the preceding claims, wherein the gear (1) is included in a housing (2).

13. A gear according to claim 12, wherein the housing (2) comprises a mounting bracket (5), which can be mounted on or is included in a frame of a bicycle.

14. A gear according to claim 13, wherein the housing (2) is mountable in the mounting bracket (5), such that the position of the crankshaft (6) bearing-mounted in the housing (2) corresponds to the standard position of such a crankshaft (6) in the bicycle.

15. A gear according to claim 13 or 14, wherein the gear (1) pre-mounted in the housing (2) can be mounted on the mounting bracket (5) with the aid of a few fastening means or detached therefrom, respectively.

16. A gear according to any one of claims 12 – 15, wherein the housing (2) comprises a cover (7), which for the purpose of inspection and maintenance of the gear (1) is readily detachable and mountable, respectively.

17. A gear for setting a transmission ratio between a crankshaft and a rear hub of a bicycle, preferably according to any one of the preceding claims, comprising

- a compact housing (2), with a crankshaft (6) bearing-mounted therein;
- a driving first sprocket (19), slideably provided on the crankshaft (6);
- a secondary shaft (8), bearing-mounted within the housing (2) parallel to and at a relative short distance from the crankshaft (6);
- a series of second sprockets (22) mounted on the secondary shaft (8) within the housing (2), mutually differing in diameter;
- a derailleur (32) positioned within the housing (2) between the crankshaft (6) and the secondary shaft (8);
- a derailleur chain in the shape of a first roller chain (20) having a link length of preferably at most approximately 3/8"(9.5 mm), which extends between the driving first sprocket (18) and one of the second sprockets (22) to be selected with the aid of the derailleur; and

a driving third sprocket (25), mounted on a part of the secondary shaft (8) extending to outside the housing (2) and coupled to a fourth sprocket (28) on the rear hub (29) by means of a second roller chain (27);

wherein said parts are dimensioned in such a compact manner that the gear in the housing, protected from moisture, dirt and damage, can be installed fitting within the usual space between the cranks of a bicycle.

18. A gear according to claim 17, wherein the derailleur (32) comprises two parallel plates (34, 35) connected with each other at a relatively short distance, and a chain tensioner (42) mounted therebetween, suitable for guiding and tensioning at least the derailleur chain (20), the arrangement being dimensioned such that the whole is positionable substantially within the space available between the driving first sprocket (18) and the series of second sprockets (22), and is movable parallel to the crankshaft (6) with the aid of an operating mechanism, in particular an operating cable (40), engaging the plates (34, 35).

19. A bicycle provided with a gear according to any one of claims 1–18, wherein the secondary shaft (8) is located between the crankshaft (6) and the rear hub (29), at approximately the same height as the crankshaft (6).

20. A bicycle provided with a gear according to any one of claims 1–18, wherein the secondary shaft (8) is located near an end of a frame tube (58) extending from a saddle (60) in the direction of the crankshaft (6).

21. A method for installing a gear according to any one of claims 12–18, wherein the gear (1) in its housing (2) is slid into a mounting bracket (5) provided on the bicycle, and is subsequently fastened to this mounting bracket (5).

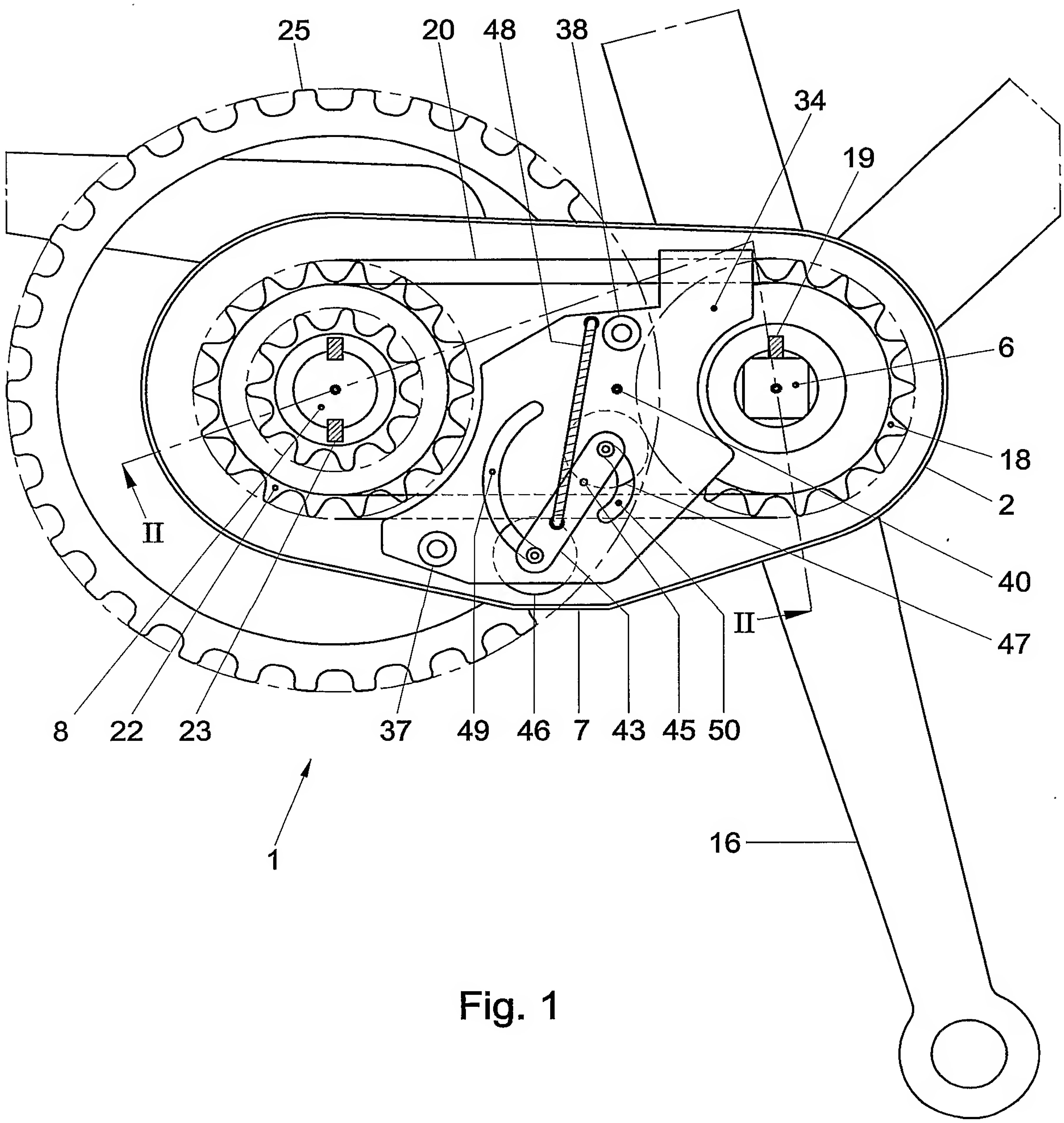
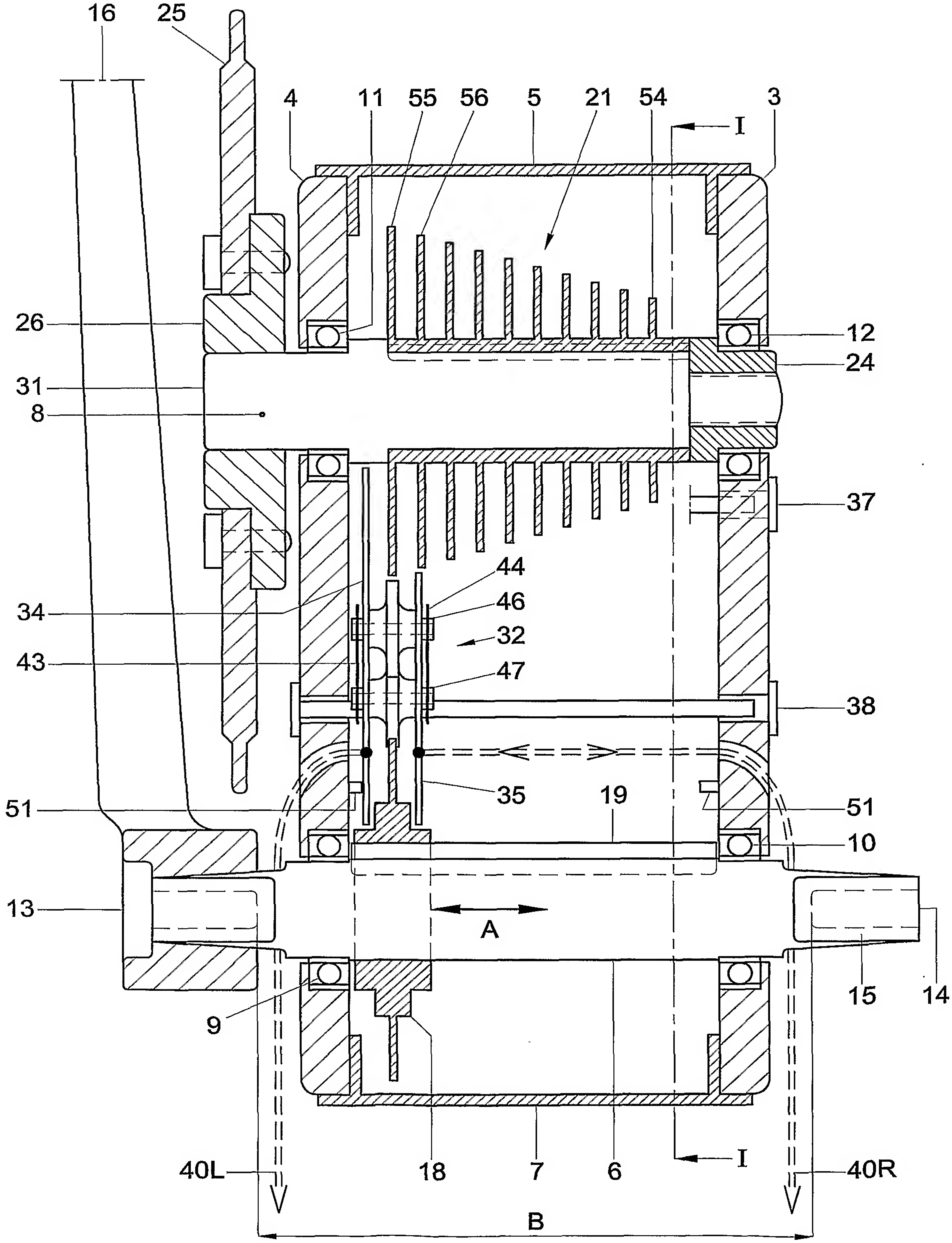


Fig. 1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I
40R
B

Fig. 2

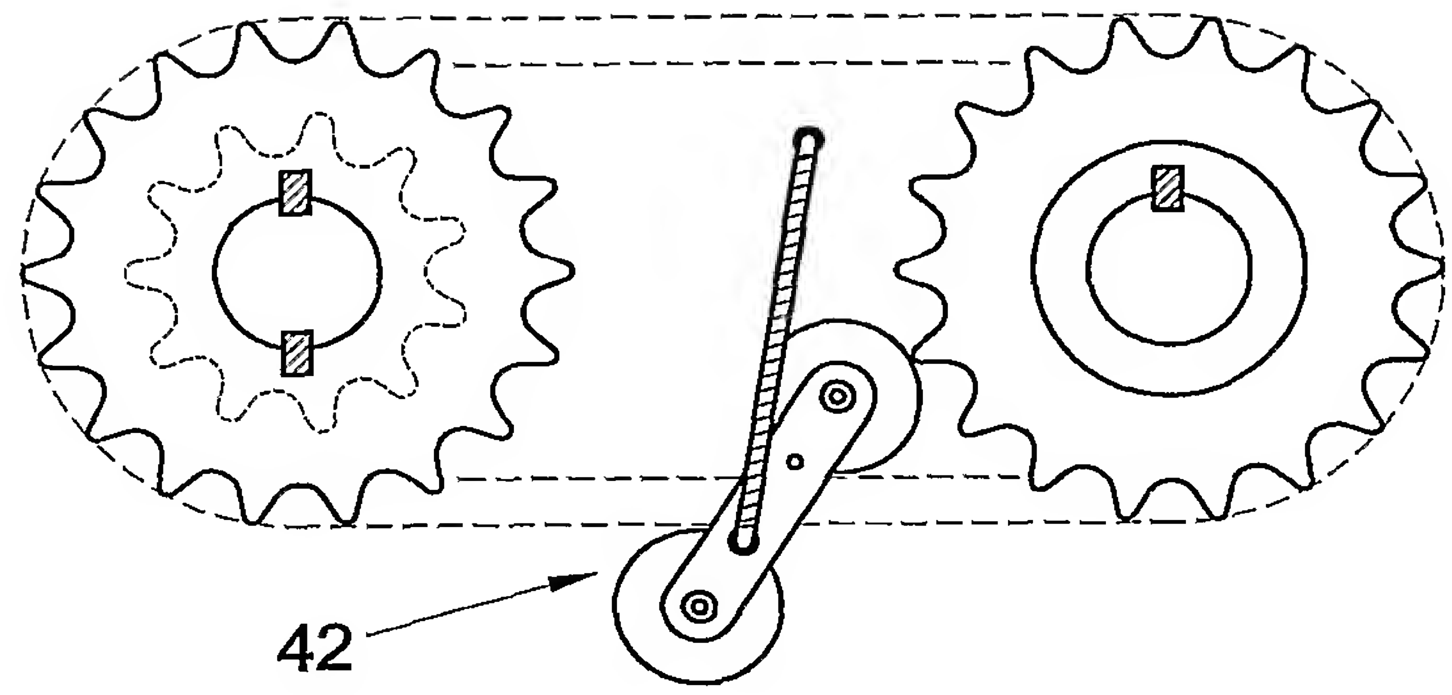

Fig. 3A

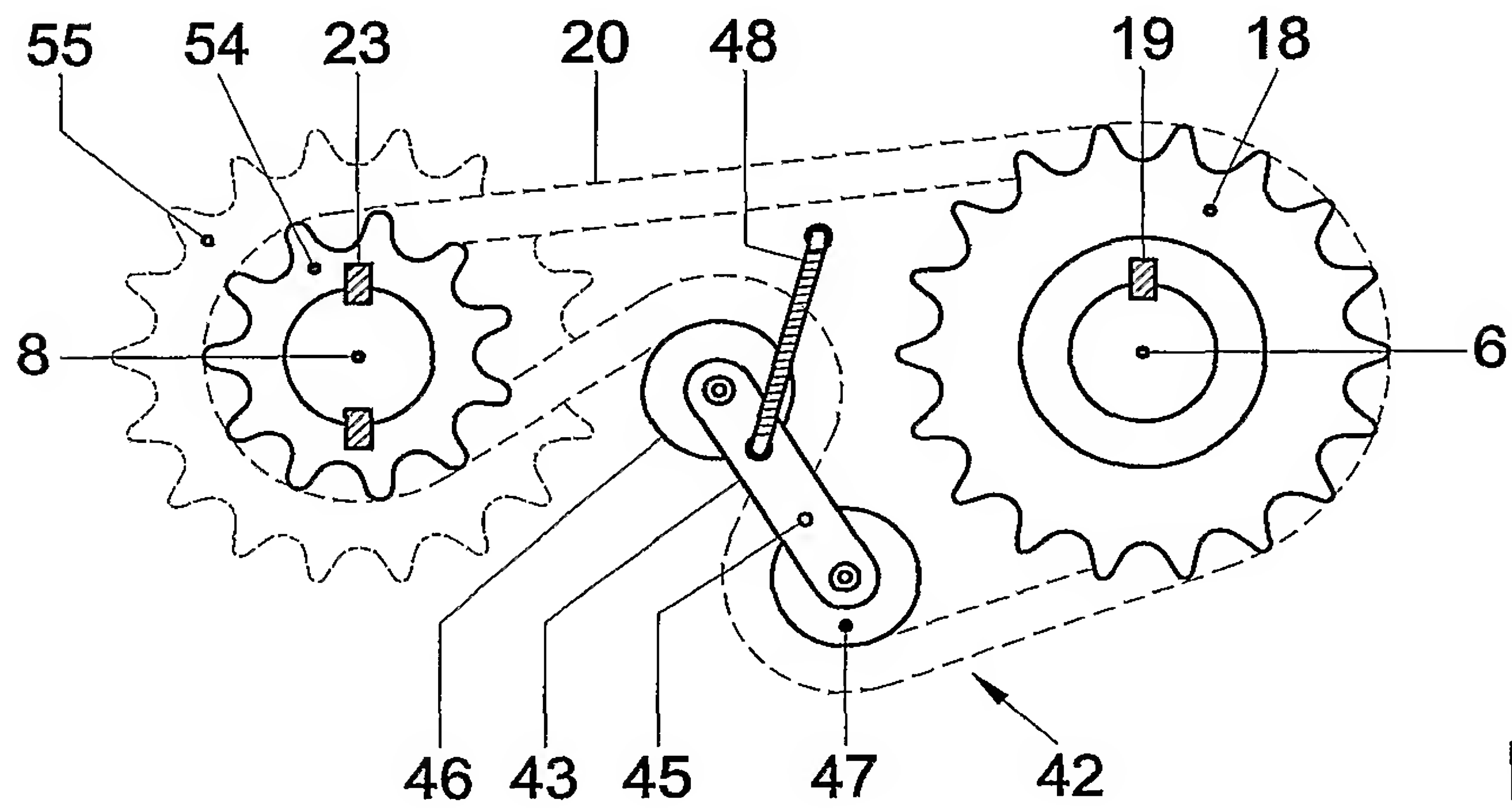

Fig. 3B

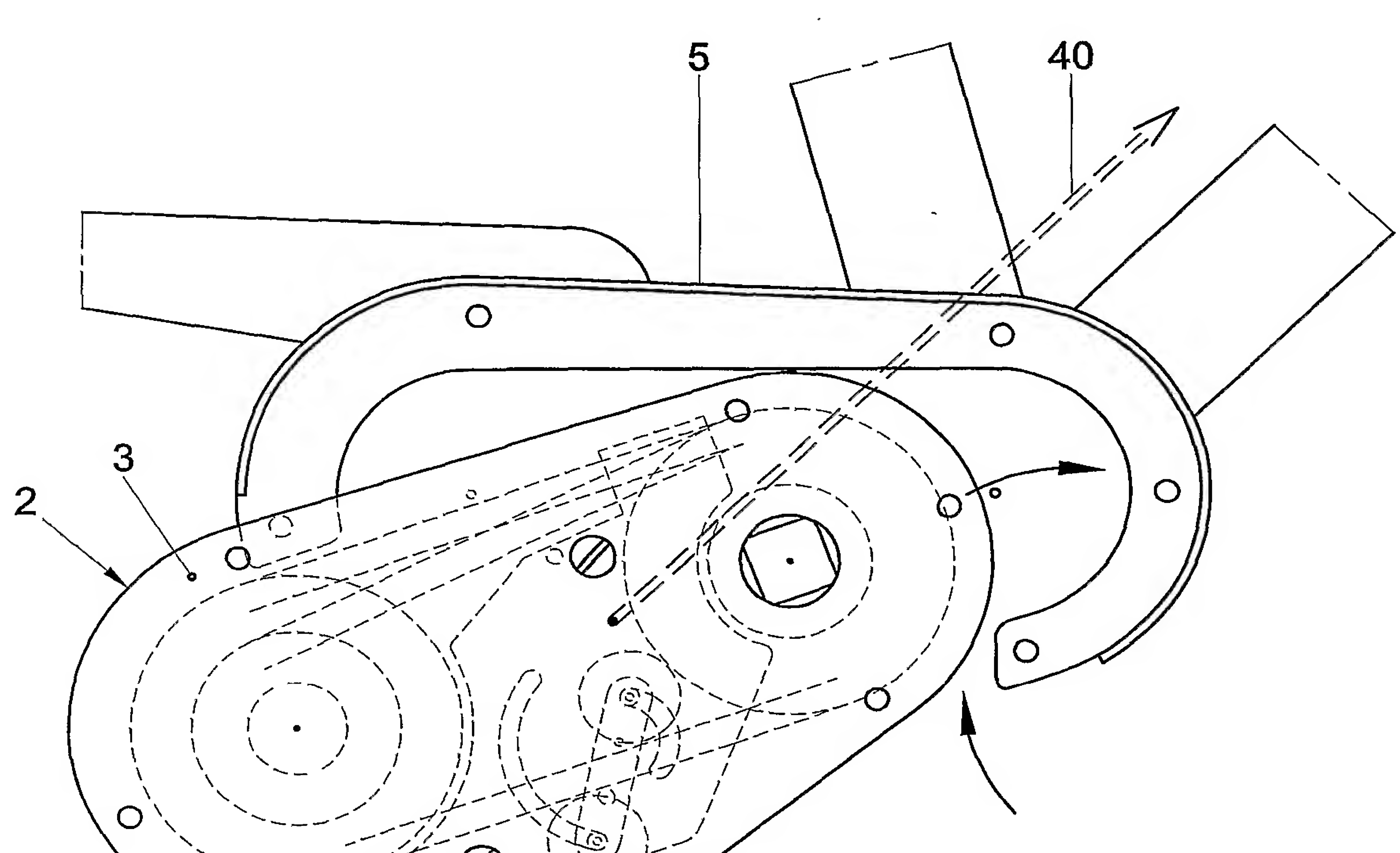

Fig. 4

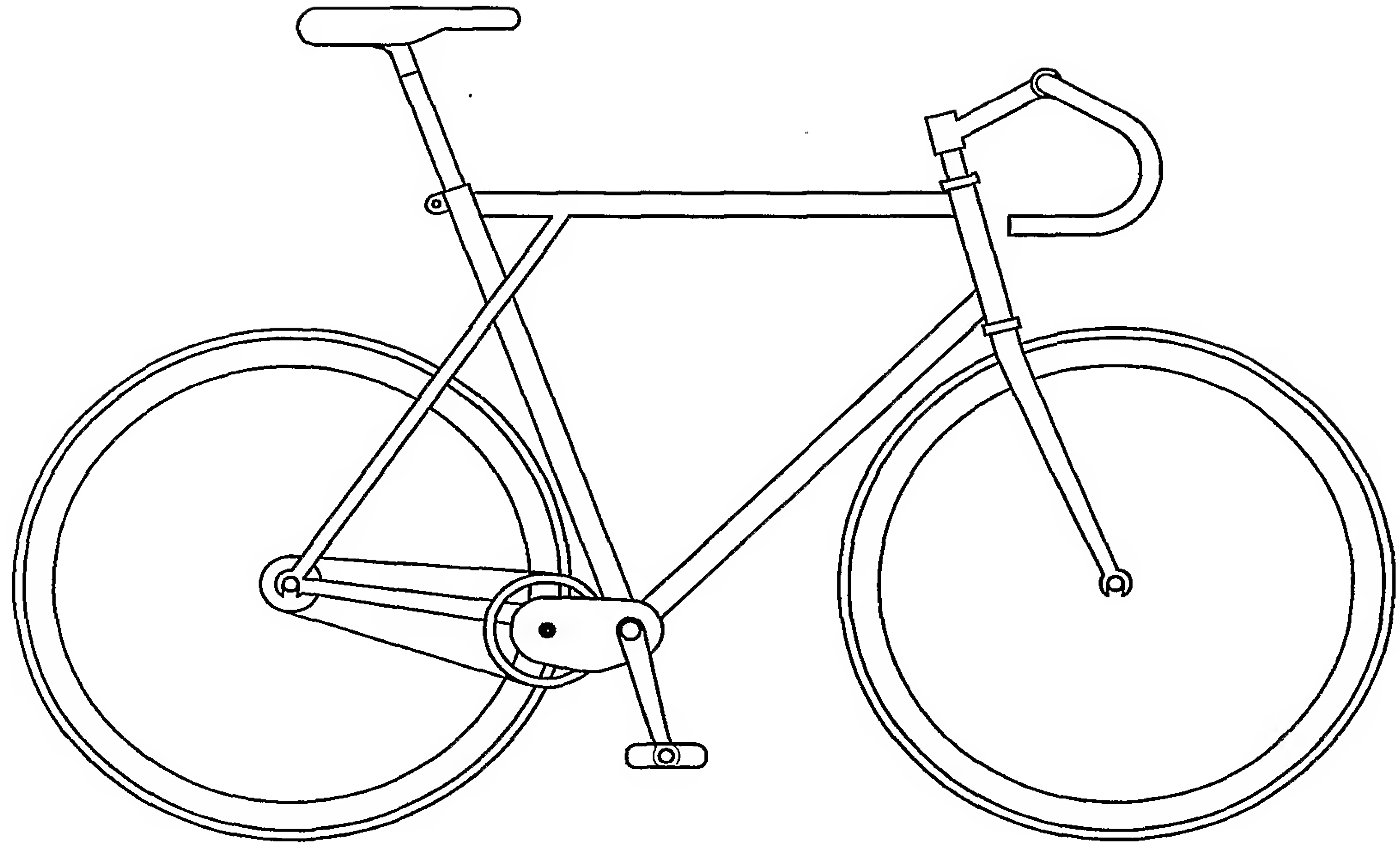

Fig. 5A

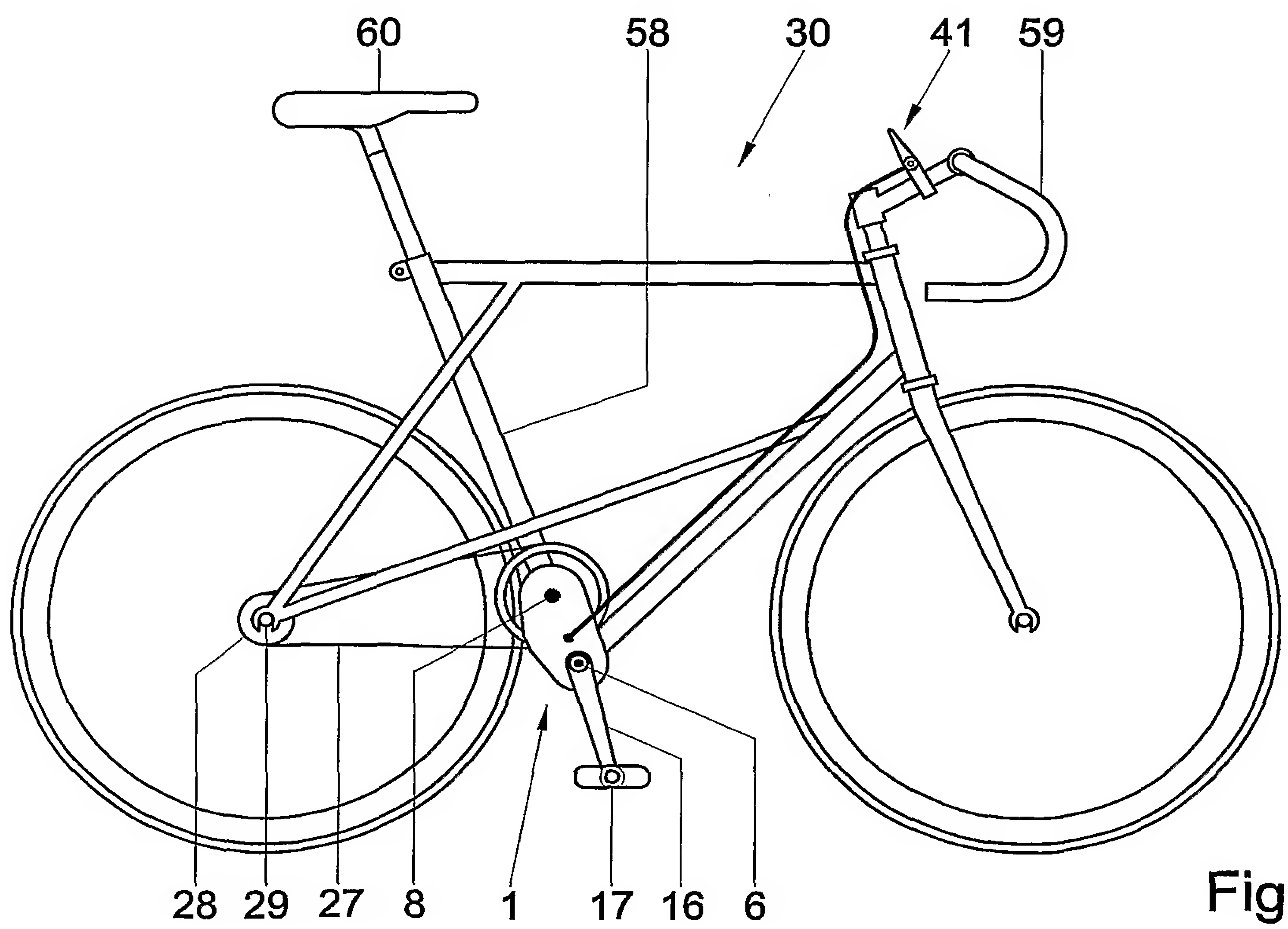

Fig. 5A

INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 01/00551

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B62M9/04 B62M11/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B62M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 39 08 385 C (MÜLLER) 13 June 1990 (1990-06-13) the whole document	1-21
A	EP 0 761 529 A (IDIT) 12 March 1997 (1997-03-12) the whole document	1-3,17
A	DE 41 29 198 A (MÜLLER) 4 March 1993 (1993-03-04) the whole document	1,17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 November 2001	16/11/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Denicolai, G

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int onal Application No
PCT/NL 01/00551

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